MARCH, 1938

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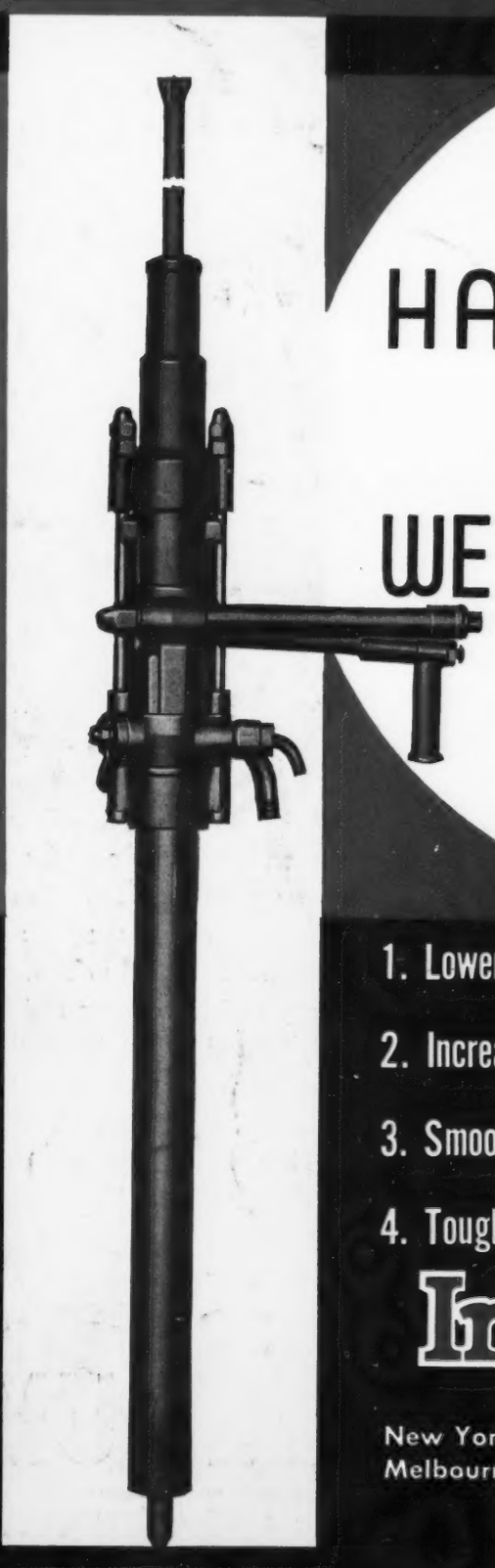

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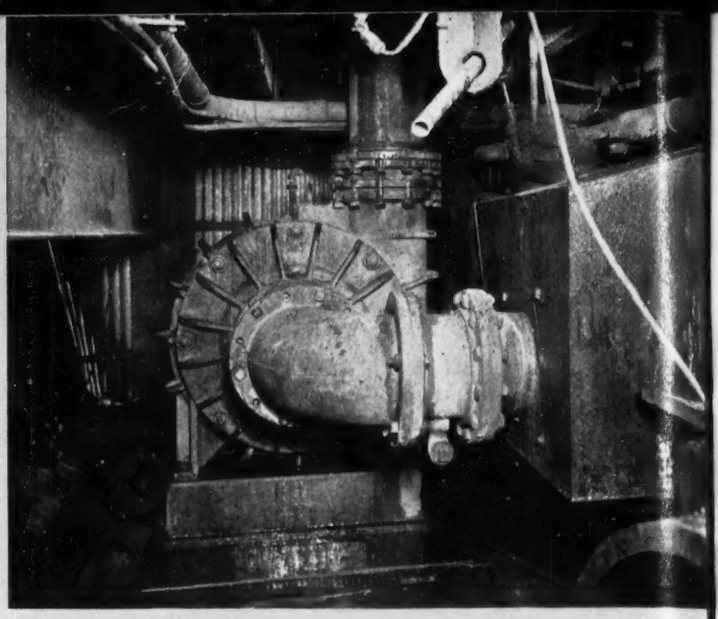

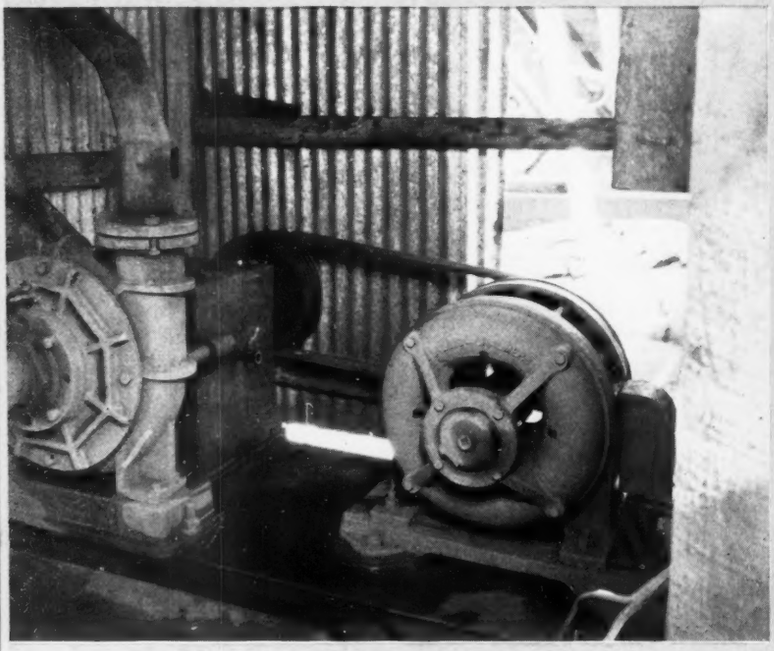

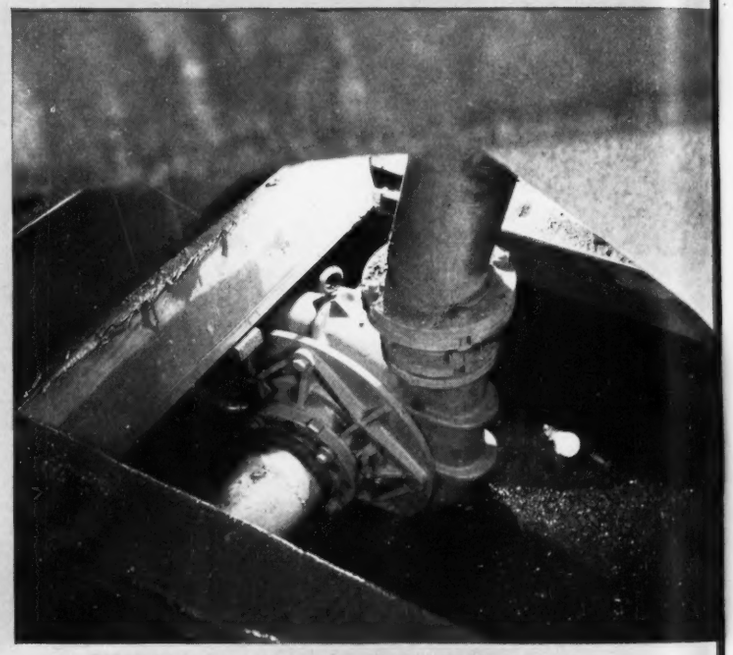

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MARCH 1938

Trade Treaties Can Create Ghost Camps

PUBLIC HEARINGS open in Washington this month on a reciprocal Trade Agreement between the United States and the British Empire. Among the numerous items on which our Government will consider granting tariff concessions are products of two major non-ferrous metals, lead and zinc. Both of these metals and their products are produced in the United States in quantities ample to supply the domestic market. Since 1922 they have been protected by moderate tariff rates, based principally on the difference in cost of production at home and abroad. These rates have been high enough to protect the home industry, but not so high as to enrich producers at the expense of consumers, nor yet too high to prevent occasional imports, as witness the importation of zinc under exceptional market conditions in 1937.

Granting the desirability of expanding international trade by the process of breaking down tariff barriers, it is impossible to see how any useful economic purpose can be served in the present instance by granting concessions to any country on lead and zinc or their products. Our resources in these metals are self-sufficient for the present. Prices are reasonable. Under such conditions it is sound policy to give moderate tariff protection to mineral industries, as the National Resources Board pointed out two years ago. Any concession on existing tariffs would be harmful enough in good times, but little short of disastrous in the present depressed state of the lead and zinc industries. At least ten Central and Western States would be affected and the welfare of several hundred thousand people jeopardized. Employment is already at a low ebb. Marginal producers are in a precarious position. Deprived of their market by imports from abroad they must of necessity succumb to cheap competition. Under no circumstances should trade negotiations with any nation consider disturbing the existing tariffs on lead and zinc products.

Economics for Engineers

OPENING ITS MEETING, as it were, with prayer, the American Institute of Mining and Metallurgical Engineers introduced at its annual February gathering in New York an innovation in the form of an economic session, at which those chosen to weigh and appraise the times and to point out the road to salvation, if they could but see it, were Dr. H. G. Moulton, president of the Brookings Institution, and Dr. Leo Wolman, professor of economics at Columbia. A large audience gave these lecturers rapt attention. Here, indeed, the average listener no doubt felt, there might be found a prescription or a formula for curing the ills which the engineer's very skill had brought upon society. However the collective mind may have run, the speakers made excellent use of their unusual opportunity.

Dr. Moulton, having the almost all-embracing subject of "Technology, Economics, Government, and Progress," dealt brilliantly with the changes wrought in the older economic picture by the growth of large-scale business enterprise and by the phenomenal discoveries and applications of science to productive processes. Despite the difficulties these have caused, he declared, society will need all the aid science can render for decades yet to come. Further rise in the living standard, he said, will be quite prevented if such policies as that of legislating against the introduction of new machinery and of reducing more and more the number of working hours are carried out. Our society can continue to progress only if labor and capital strive constantly for greater efficiency in production, and the benefits derived are broadly distributed among the masses through high wages, lower prices, or both, this if only to provide the mar-

kets for an expanding industry. Growth, he said, must rest on the expanding well-being of the entire population.

In no way disputing these long-term views and in an address dealing with the relations between labor and capital in the United States, Dr. Wolman severely questioned the efficacy of the present policy of raising wage rates and reducing hours of work. The facts, standing alone, appear to reveal a magnificent advance in American labor standards, he said, but, related to the large and persistent volume of unemployment and the serious uncertainties of the business situation, the economic policies they reflect may be considered to have done more harm than good. Conditions of labor are gaged to business conditions at the "peak of booms" and may prevent improvement when industry is on the rise or may fail to arrest a fall in a decline.

Judicious admixture of sound economics with its technical program is an intelligent step forward by the Institute. At once it gives the members something greatly needed and which serves to knit together the various sections that are so unlike in some respects.

Electrostatic Separation Comes Back

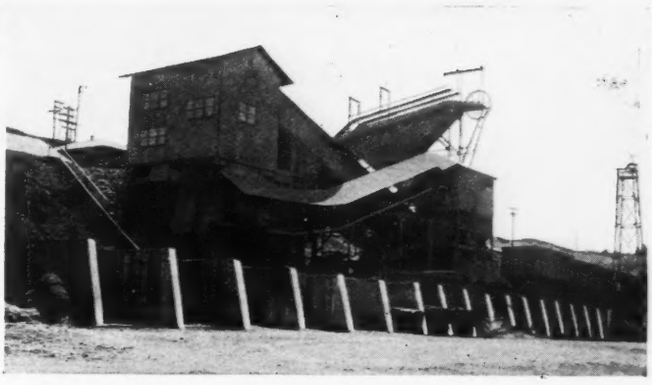
NOT SO LONG AGO, electrostatic separation seemed definitely passed into the limbo of almost forgotten processes, so far as mineral concentration was concerned. Today researchers working with it think they see new possibilities of use. The likelihood of its return to commercial status in dressing ores is heightened by the fact that it now has a foothold in the food industries, where various separators have been installed for removing insects and their products from seeds and spices, in new-found fastidiousness, before these are ground for consumption, and other applications are pending. Work on minerals-beneficiation problems has been under way at the Bureau of Mines Experiment Station, College Park, Maryland, where all kinds of non-metallic products are being studied. Various commercial groups are likewise interested, one of which hopes to separate the impurities in feldspar by electrostatic means, herein competing with flotation and table agglomeration. Opportunity also presents itself in the field of separating black sands containing titanium and zirconium minerals, which are now of commercial value. Of widest interest are the data, recently published by the Institute, on the relative susceptibilities of some 90 minerals and elements to a static charge or field, which have been derived by H. B. Johnson in tests using the most up-to-date electrical equipment and insulating materials. From all these efforts new discoveries of practical value may reasonably be expected.

Manganese and Congress

CONTROVERSY over the tariff on manganese is on again, if indeed it has ever ceased. Today the grievance of the domestic interests is (and for some time has been) that the former duty of a cent per pound has been cut in half effectively by the Trade Agreement with Brazil, the benefits of which are enjoyed also by every other country having a "most-favored nation agreement" with the United States, the net result being that Russian and African manganese, for example, as well as Brazilian, can be imported at the lowered rate —and this just when there is talk of buying manganese ore for defense! To remedy this situation in regard to the Trade Agreement seems almost hopeless, all things considered. Likewise hopeless is it to distinguish truth from half-truth and half-truth from error in the dialogues and speeches on the subject recorded in the *Congressional Record*. Perhaps Congress can be persuaded to give the domestic interests preference, if and when it decides to authorize the creation of a stockpile. Evidently the orators are striving to this end.

As to the future for a domestic manganese industry, one may glean hope from the testimony of Dr. R. S. Dean, chief of the metallurgical division of the United States Bureau of Mines, which he gave at the hearings held on the Interior Department Appropriation Bill (1938). Speaking of the Bureau's successful work in producing pure manganese metal electrolytically from sulphate solutions, Dr. Dean said: "We feel that the cost of plant and operation are comparable with similar costs for electrolytic zinc plants. . . . We do not know the exact cost of the production of electrolytic zinc in the larger plants, such as Anaconda, but it must be of the order of 5 cents per pound." He added: "The cost of manganese contained in ferro (ferromanganese is used in making steel) at present market prices is approximately 5 cents per pound." Dr. Dean said he saw no reason why the United States should not be self-sustaining with its own manganese, with the possible exception of freight. In an emergency it could supply what it needed, despite freight.

AT RAIMUND NO. 1 MINE. The tipple stands at the mouth of the slope, which follows the Big Seam as it dips down under Red Mountain at an angle varying from 15 to 45 deg. A 12-ton skip is in the act of dumping



STORAGE POCKET and crushing plant at the tipple at Raimund No. 1. The ore is crushed and sized, three sizes being made for the furnace, these varying with the latter's requirements

Red Ore From Raimund

These mines of Republic Steel Corporation, near Birmingham, have produced 12,000,000 tons to date

N. E. Thompson

Superintendent, Raimund Mine, Republic Steel Corporation Bessemer, Ala.

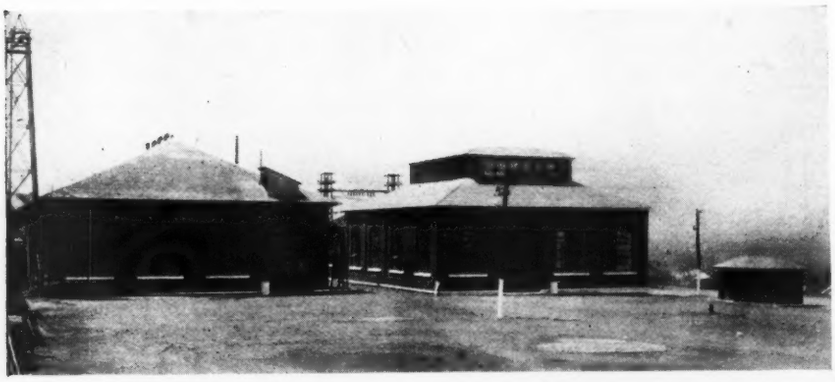
TWO GROUPS of iron mines ("red ore," or hematite, mines) are being operated by the Republic Steel Corporation in the Birmingham district of Alabama at the present time. These are the Raimund group and the Spaulding group respectively. The Raimund is situated approximately three miles south of Bessemer on Red Mountain, and is just now the principal source of red ore for the Republic furnaces. Its operations are the subject of this article.

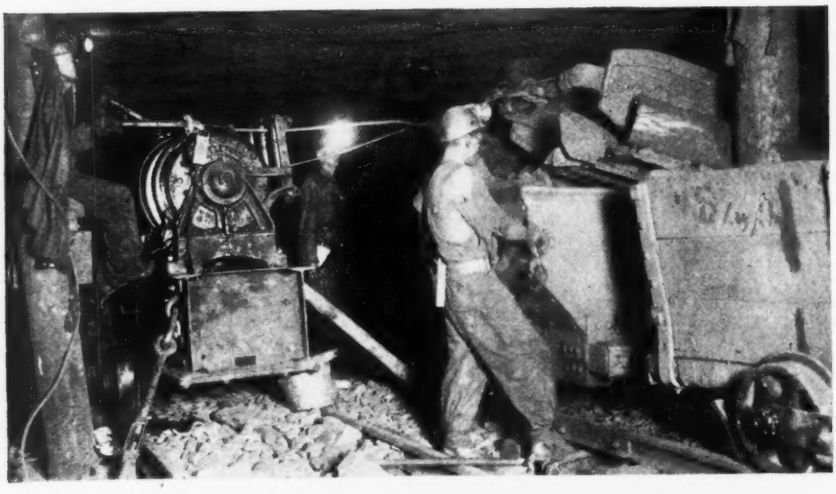
Of the workings of the Raimund group only No. 1 slope is operating, No. 2 slope having been converted into a man-and-material way in 1931 and No. 3 slope having been abandoned in 1919. Ore was first taken out of these mines by the Pioneer Mining & Manufacturing Company in 1896, and more than 12,000,000 tons has been produced from the three to date. No. 1 mine, now operating, has a normal capacity of 700,000 tons per year.

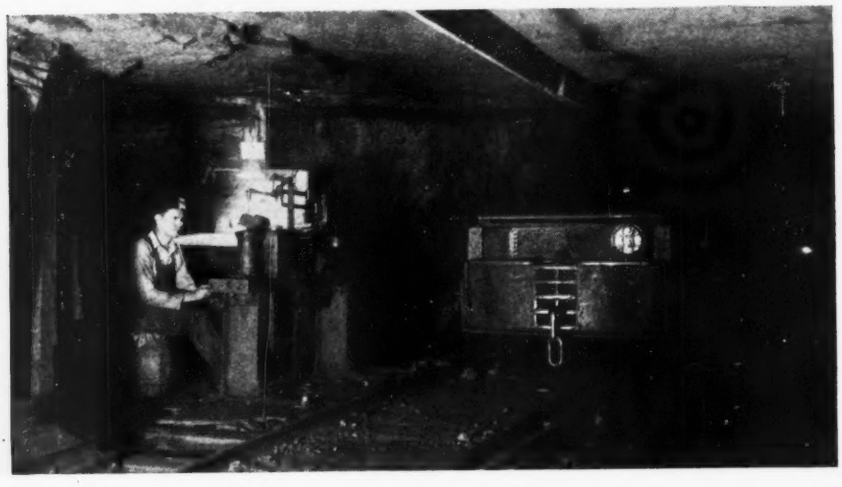
Geology—The hematite ore of Red Mountain, commonly spoken of as "red ore," occurs in the Clinton formation of Silurian age. This varies from 200 to 300 ft. in thickness and is composed largely of shale and sandstone.[1] There are four ore beds in this formation, but only the Big Seam is here considered. At Raimund, the Big Seam ranges in thickness from 5 to 12 ft., with an overburden of 1,100 to 1,400 ft. of slates, limestone, and chert, and is disturbed by numerous folds and faults, thereby complicating the work of mining. All the faults are normal, the displacement varying from a few feet to 230 ft. The grade of ore is fairly constant for any given horizon, but varies considerably from hanging to footwall, the footwall ore being highest in silica. Average analysis is as follows: iron, 33.7 per cent; silica, 10.84; alumina, 2.88; lime, 19.73; phosphorus, 0.29; and manganese, 0.15.

The mine is operating two 8-hour shifts in 24 hours on a five-day sched-

[1] E. F. Burchard and Charles Butts; U. S. G. S. Bulletin 400.







ule, and produces over 2,700 tons per day. Ore is hoisted in two 8-hour periods, at the rate of 2,600 tons per 24 hours, the excess being stored in a large underground storage pocket and hoisted to the surface on idle days. The average force required is 550 men for both surface and underground.

Development—Mining was started on the outcrop and slopes were driven in the footwall following the dip of the orebody. Headings were driven at right angles to the slopes and advanced on grades favorable to the loaded cars. They were started at intervals of approximately 60 ft. and were driven to the boundaries or to the intersection of headings from adjacent slopes. Manways were driven parallel to the slope

HOIST HOUSE (at top) and compressor building at Raimund No. 1. Hoisting equipment consists of a converted Nordberg unit having a single drum, of 10-ft. diameter and 69-in. face, geared to a 1,500-hp. motor

AT THE ROTARY TIPPLE underground. Two 4-ton box-type mine cars are in place, ready for dumping. The tipple is mounted on a shaft and set 4 deg. from horizontal. The weight of the ore dumps the cars, and counterweights right them after dumping. An oil cylinder controls the action

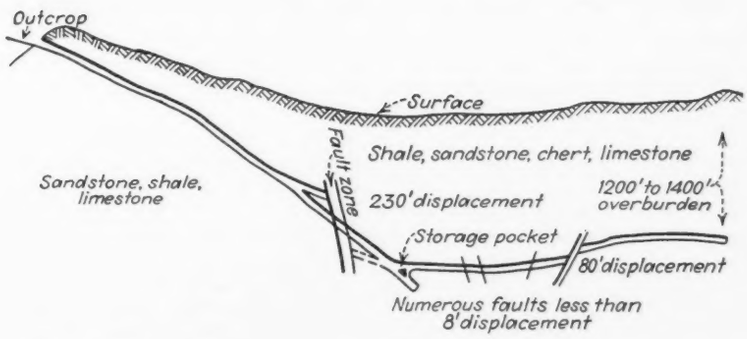
SCRAPER HOIST (at left) in Raimund No. 1. Direct-current units such as these, of 35-hp. capacity and equipped with double drums, friction clutches, and brakes, have been proved best suited to the thickness of the ore at this mine. The box-type scraper wights 1,900 lb.

ALL ORE IS WEIGHED underground on these scales (bottom). The loader is paid a fixed price per ton, less a charge for supplies used. Each car is tagged with the miner's number.

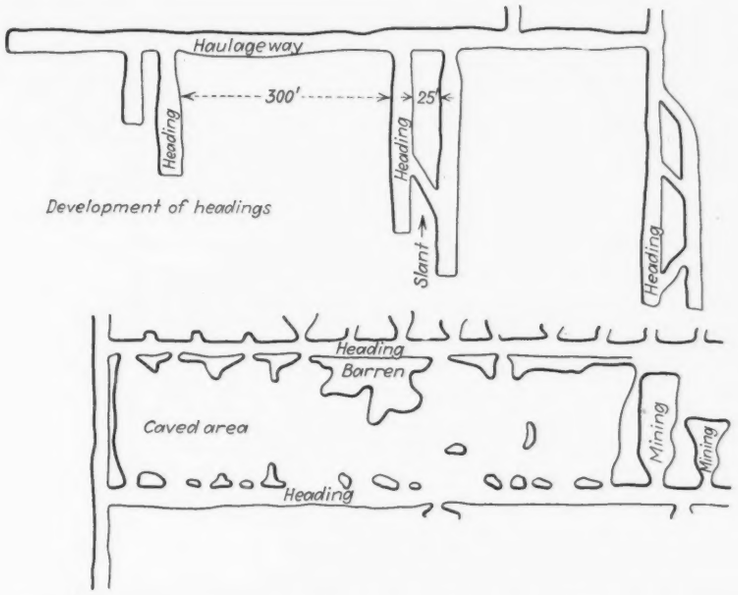
in the orebody, leaving approximately 75 ft. of ore between slope and manway for support.

Upsets or crosscuts were driven at varying distances between headings for ventilation and travelways. When the headings were advanced to their limits, more upsets were driven retreating to the manways. Approximately 40 per cent of the ore was left for support, the intention being to return later to recover as much of these pillars as possible. It is my opinion that a very small percentage will be recovered later and it is our experience today that 90 to 95 per cent of the ore can be recovered on the first operation without danger to the mine or workmen.

Present Operations—The method of



TYPICAL CROSS-SECTION of orebody, indicating the mode of occurrence, depth of overburden, and extent of faulting



MINING AND ROBBING, as typically carried out to give maximum recovery in Raimund No. 1, are illustrated in the lower sketch. Above, the methods of developing headings are shown.

mining has been changed in the past ten years to accommodate scraper mining where feasible. Headings are being driven parallel to the original slope lines in pairs, leaving 25 ft. between each heading in a pair and approximately 300 ft. between pairs. The practice is to drive these headings to the boundary 25 ft. wide and then retreat, mining all the ore possible with the use of drag scrapers. As the headings are being driven, slants are put in at 200-ft. intervals to facilitate the handling of cars after the scraper operation starts. Slate is disposed of in the abandoned workings.

After the headings are driven out, stopes are started at right angles to the headings. They are carried 12 ft. wide for a distance of 20 to 25 ft., and then widened to 30 ft. and driven 150 ft. to meet the stope driven from one of the next pair of headings. The stope is then widened in the direction of the next adjacent stope which has been previously started, and as soon as it reaches a point where the ore can be dragged through this new stope, the old stope is cleaned up and the hanging wall drilled and shot to cause a fall.

The development is five to six years in advance of the actual mining. This has given us a better opportunity to try different methods of mining and observe the behavior of the top slates. These methods have been tried in different sections of the mine and always, when the work has been completed, the top has been allowed to cave or is drilled and blasted to cause a cave. It has been our experience that the top condition adjacent to this area has been greatly benefited.

Mining — Both hand-loading and scraper-loading methods are employed. The ore is comparatively easy to drill and the latest type of 3½-in. drifter drills are used with 1¼-in. hollow-round steel in 2-, 4-, 6-, 8-, and 10-ft. length. Practically all drilling is done from a single screw-column mounting, except in unusual places of high top or in stopes partly filled with ore, where more drilling is done before scraping to keep these stopes as full of broken ore as possible.

Under these conditions a tripod mounting is used. The column mounting has been more economical both from the viewpoint of repairs and cost of the mounting and maintenance cost of the drill. Much expense and frequent delays are eliminated by cutting off the water needles so that they do not enter the shank of the steel.

After the ore is drilled, ammonium nitrate dynamite in 1½ x 6-in. sticks is used to blast the ore, the requirements being approximate'y 0.6 lb. of powder per ton of ore mined. All miners and loaders are paid on a tonnage basis. Varying flexible rates are established for the miner at a price per ton loaded in the tram cars. Each car is tagged with the miner's number and the cars are weighed on an underground scale. The loader or mucker is paid a fixed price per ton for all ore loaded, less the charge for supplies used. Allowance is made for circumstances beyond miners' control, such as those arising from heavy falls of slate and water.

Timbering—The main slopes are lined with reinforced concrete where support is necessary, one section of the No. 2 slope being gunnited for a distance of approximately 700 ft., which replaced square sets of 12 x 12-in. timber, originally placed when the slope was sunk. The main haulageways are supported by sets consisting of two legs and a collar made from 80 to 90-lb. relay rail, and have proved satisfactory over a period of seven to eight years. Single or stull timbers are used in the headings, these being 10 in. in diameter or more at the small end and varying from 8 to 12 ft. in length. All permanent timbers and ties are peeled before delivery to the mine, which materially prolongs their life.

Smaller or temporary timbers measuring 5 in. in diameter are unpeeled. These are used for support at the face, and the miner is required to quarry and make his place safe and set temporary timbers when this precaution is required. Permanent timbering and track work is done by company crews.

Electric Scraper Hoists—Thirty-five-horsepower electric scraper hoists have proved best adapted to the thickness of ore at this particular mine. These hoists are equipped with double drums, friction clutches and brakes and are driven by 35-hp. d.c. motors. The drums will hold 500 ft. of ⅝-in. wire rope, but it is the usual practice to use a larger rope for pulling in the scrapers. These ropes are generally discarded hoisting cables.

Drag scrapers of the box type are used, measuring 48 in. in width and 52 in. in over-all length and weighing 1,900 lb. complete. These are reversible and are equipped with teeth on one

side and a solid wearing plate on the opposite side. The scraper, including the bail, is a solid steel casting with holes cored for wearing strips and teeth. Our experience shows that it is best for our practice to have the teeth set at 45 deg. These scrapers will handle from 1 to 1½ tons per trip. With our present method, 100 to 150 tons per 8-hour shift is handled per scraper hoist.

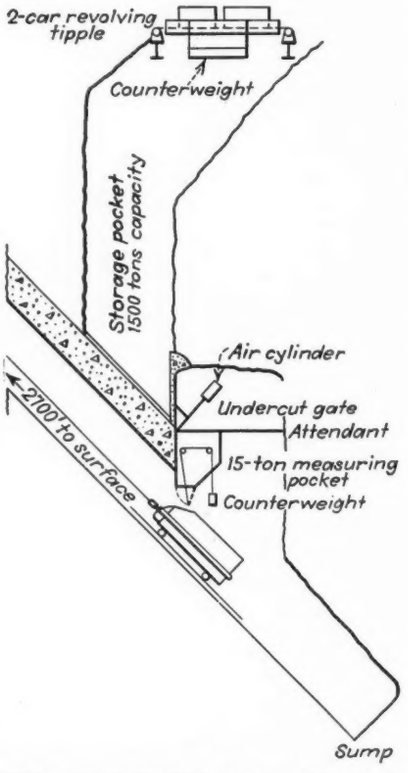
The drill steel is sharpened in an underground shop and returned to the working place by special crews. Detachable bits have been tried, and, though very successful from the standpoint of drilling, safety, and convenience, the cost was greater than with our present methods. Piston hammers and chuck parts are being built back to their original size with self-hardening rods in our own shop, and acetylene welding is used for this work. Pursuit of this practice has materially reduced the drill maintenance cost at this mine.

We have increased the length of the lugs on our drill rods from ¾ to 1⅝ in., making no change in the distance from the end of the lug to the end of the shank. This change allowed a more uniform wear on the chuck lugs, preventing a shoulder from forming, which reduced the effective blow of the piston hammer on the steel. In keeping this shoulder from forming on the chuck lug, all of the force is transmitted to the steel in a straight line instead of being partly absorbed in rotating the steel.

After the ore is broken, it is loaded into 4-ton, box-type cars of steel and wood construction, equipped with anti-friction bearings and four-wheel brakes. The cars are hauled to a storage pocket with 8- and 15-ton electric locomotives. Tracks are laid with 40-lb. rail and peeled-oak ties in the old headings; and with 60-lb. rail and creosoted oak ties in the new headings and haulageways. The tracks are all bonded and in addition discarded hoist cables are stretched out along the tracks and bonded to the rails at 200-ft. intervals to improve the return circuit.

Ore is dumped into the storage pocket two cars at a time by a revolving tipple mounted on and revolving around a 5-in. shaft. The weight of the ore dumps the cars and counterweights on the opposite side of the shaft right the tipple. The entire action is automatic and is controlled by an oil cylinder. Ore is drawn from the storage pocket into a measuring pocket and then dumped into a 12-ton skip equipped with anti-friction bearings. It is then hoisted to the surface over an incline varying from 15 to 45 deg., where it is dumped into a 150-ton storage pocket by elevating the rear wheels. The ore is crushed and sized through primary and secondary crushers, and a shaker screen, three sizes being shipped to the furnace, varying with their requirement. The general practice is to ship 1¼ in., ¼ to 1¼ in., and ¼ in. products.

Hoisting equipment consists of a converted 30x60-in. heavy-duty single-drum Nordberg hoist, with a drum 10 ft. in diameter and having a 69-in. face grooved for 1⅜-in. hoisting cable, geared to a 1,500-hp. motor with herringbone gear and pinion. Mechanical, dynamic, and regenerative braking are used to retard and stop the trip.



FROM TIPPLE TO SKIP on the hoisting slope. The arrangement of the revolving dump, the storage pocket, and the measuring box for loading is shown

Men and materials are handled over our No. 2 slope in a combination man-and-material car holding 30 men. This car is equipped with a safety device attached to the bottom through which an independent special 1½-in. steel cable is threaded. The action is dependent on the tension of the main hoisting cable, and adjustment can be made for varying loads and inclines. A single-drum hoist equipped with a 700-hp. motor and with mechanical and dynamic braking is used to handle this car.

Compressed air is furnished at a pressure of 100 lb. per square inch by three electrically driven air compressors, two with a capacity of 3,146 cu.ft. each, and one with a capacity of 1,320 cu.ft. The main air lines are 8 in., with receivers both inside and at the compressors. Branch lines of 4-in., 2-in. and 1-in. pipe are used to distribute the air.

Electric power is furnished by the Alabama Power Company at 44,000 volts to a substation, where it is stepped down to 2,300 volts for general use. Our demand charge is a considerable item and much attention is paid to staggering loads, such as pumping, compressing air and hoisting, an exhaustive study having been made and a regular schedule being rigidly adherred to in order to prevent high peaks.

Direct-current power for operating ten 8-ton, two 15-ton electric locomotives, scraper hoists, small gathering pumps, and lights is furnished by two stationary motor-driven generator sets and one portable motor-driven generator set. These are situated to the best advantage for load distribution.

All water is pumped to surface from two main pumping stations, one at No. 1 mine and one at No. 2 mine. These pumps are all electrically-driven centrifugal pumps. A small amount of water is made in the active workings, which is relayed to the main pumping stations by small electric and air pumps. Total water pumped to surface is approximately 1,000,000 gal. per 24 hours.

Ventilation—The active workings comprise an area of approximately 320 acres, and until recently the ventilation was dependent on the natural flow of air from No. 2 to No. 1 mine, augmented by the air released from the drills. At present the air is circulated by a Jeffrey fan mounted over No. 2 slope forcing the air through the workings and returning through No. 1 slope. Suitable rock-plaster stoppings and air-lock doors are used to insure a sufficient circulation of air through the workings.

Safety—Edison battery cap lamps are used throughout the mine, and no open lights are allowed; nor is smoking permitted. Blasting fuses are lighted with a hot wire lighter.

Accident prevention ranks first in the operation at Raimund mine. Rigid discipline is maintained and a system of penalties for violations of safety rules is used, and employees are penalized for potential accidents rather than after the accident occurs.

The wearing of "hard-boiled" caps by all underground workers is compulsory; and the wearing of safety shoes is encouraged, and has been instrumental in preventing serious toe injuries. Wearing of screen goggles is compulsory when breaking ore or rock with a hammer, when collaring drill holes, and when cutting hitches for timbers. These items are sold to the employees at cost.

Xanthate-Soap Flotation

Proves Useful in Copper Country

Tailings and ores amenable to treatment. Process employed at Freda Mill

W. E. Keck
Assistant Professor

Paul Jasberg
and
A. E. Schnaufer
Laboratory Research Assistants

Michigan College of Mining and Technology, Houghton, Mich.

EXPERIMENTS on a high-sulphur iron ore showed that a mixture of ethyl xanthate and sodium oleate eliminates the oxide-stained pyrite more completely than does amyl xanthate. When the ore was floated (a) with 0.10 lb. of amyl xanthate, the tailing contained 0.23 per cent sulphur and 95 per cent of the iron in the feed; (b) with 0.20 lb. of ethyl xanthate, the sulphur content of the tailing was 0.35 per cent and 96 per cent of the iron was recovered in it; and (c) with 0.05 lb. of sodium oleate, 0.10 lb. of ethyl xanthate, and 2.0 lb. of fuel oil, the sulphur in the tailing was reduced to 0.15 per cent and this product had 90 per cent of the iron. The combination of xanthate and sodium oleate was further tested with weathered amygdaloidal copper tailing[1] and with an oxidized gold ore.

In the Copper Country of Michigan, considerable quantities of tailings have accumulated from the milling of native copper ores. These tailings products, or "sands,[2]" contain small quantities of copper and, in some instances, traces of silver. Only the richer of the amygdaloidal sands[3] were studied in this work. All the larger piles of these sands are partly submerged in Lake Superior or connected lakes of the district; the quantities of submerged sands in the different piles range from 50 to 90 per cent of the total content. Study of the United States Engineers' records[4] showed marked seasonal and cyclic fluctuations in the elevation of Lake Superior since the sands were dumped into this lake or connected lakes—material from 1 ft. or more above water surface (at the time of sampling) having been continuously above water. In the same way, material 3 ft. or more below water line has been continuously immersed. Further, the sands between these two zones had been completely exposed to atmosphere during a part of 1926 and submerged at other times. Because of this condition, the sands from the three zones were placed in separate samples. The origin of the samples in regard to elevation is designated as follows: the surface of the water at the time of sampling is taken as the datum point, and distances above and below this point are respectively given positive and negative values.

"Float and sink" analyses of some of the samples produced a good separation of copper and copper-bearing gangue from the barren gangue, whereas other samples showed little separation. Results from the amenable sands indicated that a considerable portion of the uncomminuted barren material could be eliminated, theoretically at least, by gravity concentration. However, the theoretical possibilities were not realized in jig and table tests. Even the best of these results were unsatisfactory.

Microscopic study of the sands indicated that the copper occurred largely with the lime- and iron-bearing minerals. This fact was also substantiated by hand picking of the sands, all of the samples showing concentration of the copper in the gray and green-colored minerals. In the samples from one sand pile, the gray and green minerals contained from 1.0 to 1.2 per cent copper, whereas the brown ones contained only 0.06 per cent copper. Inasmuch as gravity concentration failed to take advantage of this marked segregation of the copper, flotation of the sands was studied.

The laboratory batch flotation tests were performed in the usual way in a 500-gram mechanical cell. In the first experiments, +65-mesh copper was removed by screening the pulp before flotation, but with later tests, when the flotation feed was much coarser, the tailing products were tabled to remove the coarse copper.

These tests soon showed that the sands were refractory to flotation with ethyl xanthate. Further, they also showed that a satisfactory recovery could not be made except with a prohibitive amount of grinding. Finally this work proved that the surface sands were much more refractory to flotation than were the submerged ones.

The data of Table I show that the —3 ft. to +8½ ft. sands were floatable only with difficulty, whereas the —3 ft. to —5½ ft. sands were more readily floatable. These results were correlated with the data on the fluctuation in the elevation of the surface of Lake Superior[5] which has occurred since the sands were produced. This correlation indicates that material which had been continuously submerged was relatively floatable and that the sands which had been above water for several months or more were very refractory to flotation. From these facts it was concluded that inferior flotation of the surface sands was caused by oxidation of the copper. These sands apparently had been oxidized differently or to a greater extent than had the submerged material. Copper from the submerged sands was dull-colored; but grinding to the extent noted in the foregoing brightened it and rendered it floatable, whereas even much more intense grinding of the surface sands did not materially increase the floatability of the copper in them.

Further flotation of the surface sands with varying quantities of amyl xanthate, ethyl dixanthogen, amyl dixanthogen, and a proprietary collector for copper oxide minerals yielded results which were no better than those obtained with ethyl xanthate. Sulphidization and flotation with ethyl xanthate slightly improved recovery; but even when this procedure was combined with a prohibitive amount of grinding, the recovery was too low.

Inasmuch as all of the flotation of the sands described in the foregoing was unsatisfactory, study of the problem from this angle was discontinued. Instead, the sands were tested with a combination of ethyl xanthate and sodium oleate.

In the batch laboratory tests, the sands were coarsely ground and the pulp was separated into + and —200-mesh portions by screening. The +200-mesh portion was floated and

the flotation tailing was then tabled. The —200-mesh portion was not tested, because this size of ore generally is refractory to soap flotation. From 70 to 80 per cent of the floatable copper in the coarse sands was recovered, but the quantity of sodium oleate concentrate was relatively large. Regrinding of this material being necessary, further work was done to reduce its quantity. These tests were similar to the foregoing except that oleic acid, fuel oil, and soda ash were used instead of sodium oleate. This change increased the recovery of copper and also markedly reduced the quantity of oleic acid concentrate.

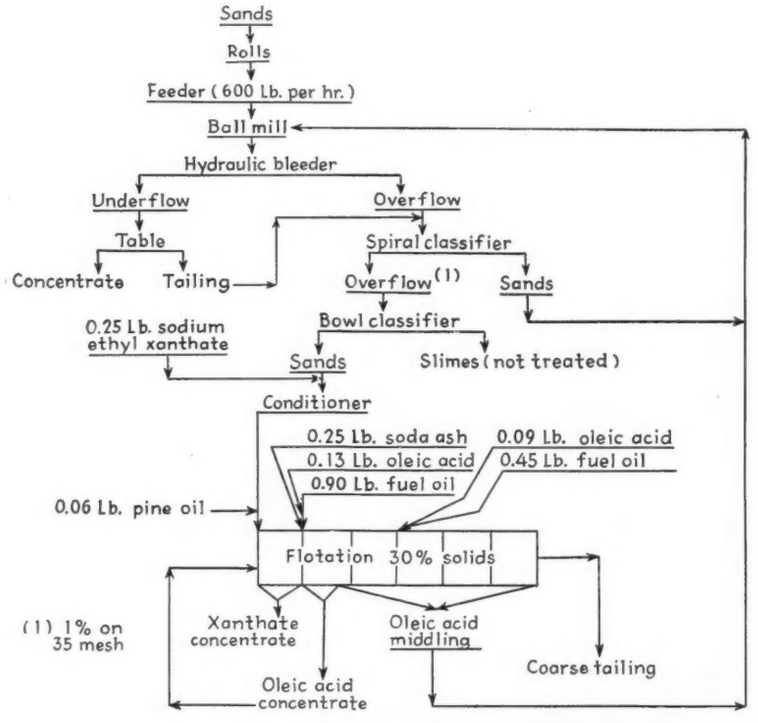


Fig. 1 . . . A CONTINUOUS LABORATORY TEST, run on surface sands according to this flowsheet (based on the preceding four-batch locked tests), was made to determine whether xanthate-oleic acid flotation could be used in a continuous process. See Table II for the metallurgical results

A four-batch locked test was then performed to determine whether the xanthate-oleic acid flotation could be combined under conditions which simulated a continuous process. The conditions of this test resembled, in general principles, those of the continuous laboratory test shown in Fig. 1. The coarse copper was removed by tabling the flotation tailing instead of by hydraulic bleeding and tabling, and a 200-mesh screen was used instead of the bowl classifier. Also, the slimes (not treated in Fig. 1) were floated with 0.29, 0.02, 0.06, and 0.08 lb. respectively of xanthate, oleic acid, fuel oil, and pine oil. The grades of xanthate concentrate, oleic middling, coarse, slime, and general tailings were respectively 29.9, 1.9, 0.094, 0.117, and 0.102 per cent copper, and the flotation recoveries of floatable copper were as follows: coarse sands, 76.7; slimes, 63.7; and over-all recovery, 72.3 per cent.

Further locked tests showed that the laboratory tap water (lime and chloride, 39 and 18 p.p.m.) and the water of Lake Superior and connected lakes adjacent to the sand piles were suitable for xanthate-oleic acid flotation. They also showed that the surface sands were as amenable to beneficiation with this process as were the submerged ones.

The locked tests having been successful, the process was further tested with a continuous laboratory flowsheet. Surface sands were used in this test because they were easily available and because their flotation would give conservative results. The treatment of the sands is shown in Fig. 1. Classification of the ground sands (overflow from spiral classifier) in the bowl classifier yielded two parts of sand and one part of slime, 25 per cent of the sands passing through 200 mesh and 4 per cent of the slimes remaining on 200 mesh. The oleic acid middling which was returned to the ball mill was 4 per cent of the feed and contained 2.3 per cent copper. The flowsheet was operated for sixteen hours. Data from the final two hours of operation are given in Table II; they show that the coarsely ground surface sands were amenable to xanthate-oleic acid flotation.

Finally, the process was tested with a 350-ton unit in one of the mills of the district. Several changes in the flowsheet were made to fit it to the available equipment. The flowsheet which had been altered in this way is shown in Fig. 2. With this flowsheet, the average analyses of the products from a five-day test were as follows: xanthate rougher concentrate, 16.8; oleic acid concentrate, 2.0; cleaner tailing, 9.1; cleaner concentrate, 36.8; fine tailing, 0.124; coarse tailing, 0.090; and general tailing, 0.107 per cent copper. These results were obtained with 0.15 lb. of sodium ethyl xanthate, 0.16 lb. of sodium sulphide[6], 0.07 lb. of single distilled red oil (crude commercial oleic acid), 0.15 lb. of fuel oil, and 0.09 lb. of pine oil.

Comparison of these results with those from a similar unit which received the same quantity of feed but which was operated entirely with xanthate flotation and without a bowl classifier and concentrate cleaner yields the following facts: Both processes used the same quantities of xanthate and pine oil and their grades of concentrate were approximately equal. Thus the additional cost for xanthate-oleic flotation consisted of 1.65c. per ton for reagents[7] and undetermined costs for bowl classification of the xanthate tailing (cut at between 100 and 150 mesh) and concentrate cleaning which required 10 cu. ft. of cell capacity. Under these conditions, the xanthate oleic-acid flotation recovered 1½ lb. more of copper per ton of sands than did the xanthate flotation.

The difference in results from the two processes was explained by microscopic examination of their products. The oleic acid concentrate was composed of small quantities of very coarse oxidized copper and large quantities of calcite, prehnite, and epidote which contained unliberated copper. This product also carried quartz which contained very small particles of exposed copper. (The exposed copper apparently functioned as nuclei from which fllming of the gangue particle proceeded, for the corresponding tailing contained much similar material without exposed copper.) The copper minerals in the xanthate concentrate from xanthate-oleic acid flotation were composed mostly of malachite and cuprite-coated native copper with smaller quantities of bright native copper, cuprite, azurite, and malachite. Loss in the tailing from xanthate flotation was due mostly to oxidized and unliberated copper and to a lesser extent to coarse flake copper which was not floated and not recovered by gravity concentration.

Microscopic study also revealed that the xanthate-oleic acid flotation was more selective than the usual soap or fatty acid flotation. The floated particle probably was first covered with a highly selective xanthate film which

then attracted the less selective but strong collectors, oleic acid and fuel oil, a very selective and powerful flotation being obtained in this way.

Consideration of all the foregoing data shows that, in xanthate flotation, not only was grinding done in the necessary freeing of the copper but it was also needlessly done in wearing away the oxide coating on the native copper and in grinding nearly barren gangue—the latter grinding being done unavoidably during the wearing away of the oxidized material on the native copper. With xanthate-oleic acid flotation, polishing of the native copper to remove the oxidized exterior was not necessary because oxidized copper is floated as readily as bright copper. This improvement automatically removed the useless grinding of barren gangue which hitherto had been done unavoidably during cleaning of the oxidized copper. Further, this process affected additional saving in grinding cost because it was only necessary to free the copper-bearing from the barren gangue and then float and regrind the rich gangue, which was about 4 per cent of the sands. Finally, the new process recovered cuprite, malachite, and azurite and deeply oxidized native copper which were entirely refractory to xanthate flotation. It also recovered very coarse flake copper which likewise could not be floated with xanthate only or recovered by gravity concentration.

The process is now being commercially applied to amygdaloidal sands at the Copper Range (Freda) Mill. The flowsheet is similar to the one of Fig. 2 except that the bowl classifier has been eliminated and the coarse and fine sands are floated together with red oil and fuel oil after they have been floated with ethyl xanthate and sodium sulphide. Also, the xanthate concentrate is cleaned more rigorously to maintain its required grade. Under the particular conditions, this altered flowsheet is preferable to the one of Fig. 2 and the results with it are fully as good as or better than those of the five-day test with the flowsheet in Fig. 2.

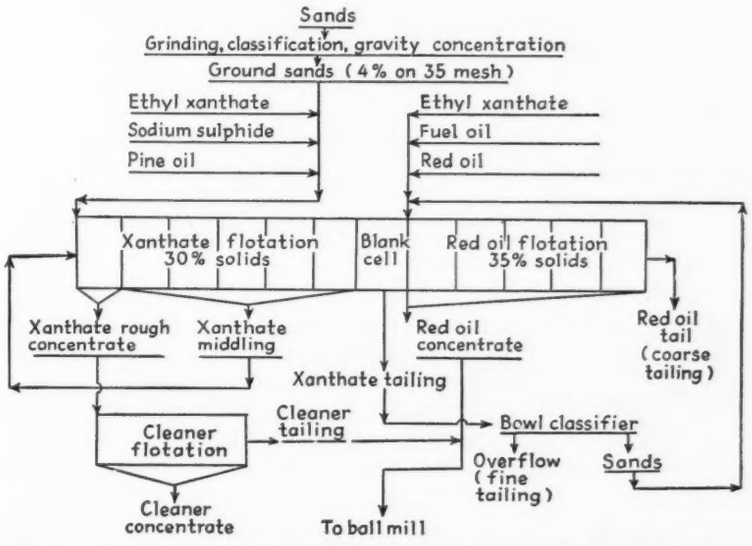


Fig. 2. . . A TEST IN A 350-TON UNIT of a Copper Country mill was made, according to this flowsheet, to test the process after the continuous laboratory tests had been found successful

After the experiments on the sands had been completed, several batch laboratory tests were made on virgin amygdaloidal ores of the district. The ores were ground as pass 35 mesh and the succeeding treatment simulated, as nearly as it was possible, the conditions of flotation in Fig. 2. With this treatment, concentrates of the usual grade were produced and the coarse and fine tailing contained respectively 0.09 and 0.08 per cent copper. When the ores were of relatively fine texture, or when the native copper was segregated in certain of the gangue minerals, these tests indicated that a considerable saving in grinding could be effected by the xanthate-oleic acid process. The saving was brought about by the flotation of middling and copper-bearing gangue minerals. Both of these materials require regrinding, but as they are 4 to 6 per cent of the ore, it is necessary to regrind only a small part of the ore so that the copper is freed, whereas with xanthate flotation all of the ore must be ground to the same extent.

As previously indicated, xanthate-oleic acid flotation was also tested with a partly oxidized gold ore. The ore was considerably weathered and the gold occurred both free and with badly stained pyrite and manganese and iron oxides. It contained 0.8 oz. of gold and several ounces of silver per ton. In practice, the ore was floated, then the flotation tailings were tabled, and both concentrates were shipped for smelting.

In these tests the ore was ground in a laboratory rod mill so that nearly all of it passed 80 mesh. Then it was floated in a 500-gram mechanical cell with 0.50 lb. of amyl xanthate, 0.10 lb. of pine oil, and 1.0 lb. of soda

(*Continued on page* 42)

Table I

Floatability of Sands From Different Elevations With 0.10 lb. Potassium Ethyl Xanthate and 0.10 lb. Pine Oil. Sands Ground to 1% on 65 Mesh and 74% Through 200 Mesh

Elevation	Recovery of Copper —65 Mesh
+3 ft. to +8½ ft.	11.1
0 to +3 ft.	16.8
0 to —2 ft.	19.6
—2 ft. to —3 ft. (*a*)	25.9
—2 ft. to —3 ft. (*b*)	49.2
—3 ft. to —4 ft.	75.6
—4 ft. to —5½ ft.	79.7

(*a*) Sample from middle of zone.
(*b*) Sample from bottom of zone.

Table II

Continuous Laboratory Test on Surface Sands With Xanthate, Oleic Acid, Fuel Oil, and Soda Ash (Fig. 1)

Product	Grade	Flotation and Tabling Distribution	Flotation and Tabling Recovery	Flotation Distribution	Flotation Recovery
Xanthate Concentrate..	26.8	52.0		73.9	
Coarse Tailing	0.074	18.4		26.1	
Table Concentrate	7.79	29.6			
		100.00	81.6	100.00	73.9

Footnote References

[1] "Xanthate-Soap Flotation Promising for Recovery of Coarse Oxidized and Native Copper," E. & M. J.,, Vol. 138, No. 10, 44, 1937.

[2] Throughout this article the tailings will be referred to by the local designation, "sands." This procedure will prevent confusion of these materials with the tailings from the present experimentation.

[3] This work did not include the hard, finely textured conglomerate ores or sands for which a satisfactory combination of gravity concentration, leaching, and flotation has been developed. (C. H. Benedict: "Methods and Costs of Treatment at the Calumet and Hecla Reclamation Plants." U. S. Bureau of Mines I. C., 6357, 1930). The sands from the gravity concentration of low-grade coarsely textured amygdaloidal ores and those which have been produced since the introduction of xanthate flotation were also omitted because the copper contents of both of these materials were too low for practical reclamation. Treatment of the weathered sands is an entirely different and much more difficult problem than that of the fresh amygdaloidal ores or their current products for which commercial flotation was developed in 1928. (A. W. Fahrenwald: "Copper Milling Research in Michigan," U. S. Bureau of Mines R. I. 2878, 1928.) Thus the present experiments have no connection whatsoever with the fresh amygdaloidal ores or their current products.

[4] The authors are indebted to G. H. Banks, assistant engineer, U. S. Engineers Office, Houghton, Michigan, for this information.

[5] See the second paragraph, this article.

[6] The loss of oxidized copper in the fine tailing was considerably reduced by the addition of sodium sulphide.

[7] Based on prices, delivered at mill, of 4.1 cents for sodium sulphide, 12 cents for red oil and 1 cent per pound for fuel oil.

Cyprus Mines

Concretes 520-Ft. Circular Shaft Without Interruption to Mucking

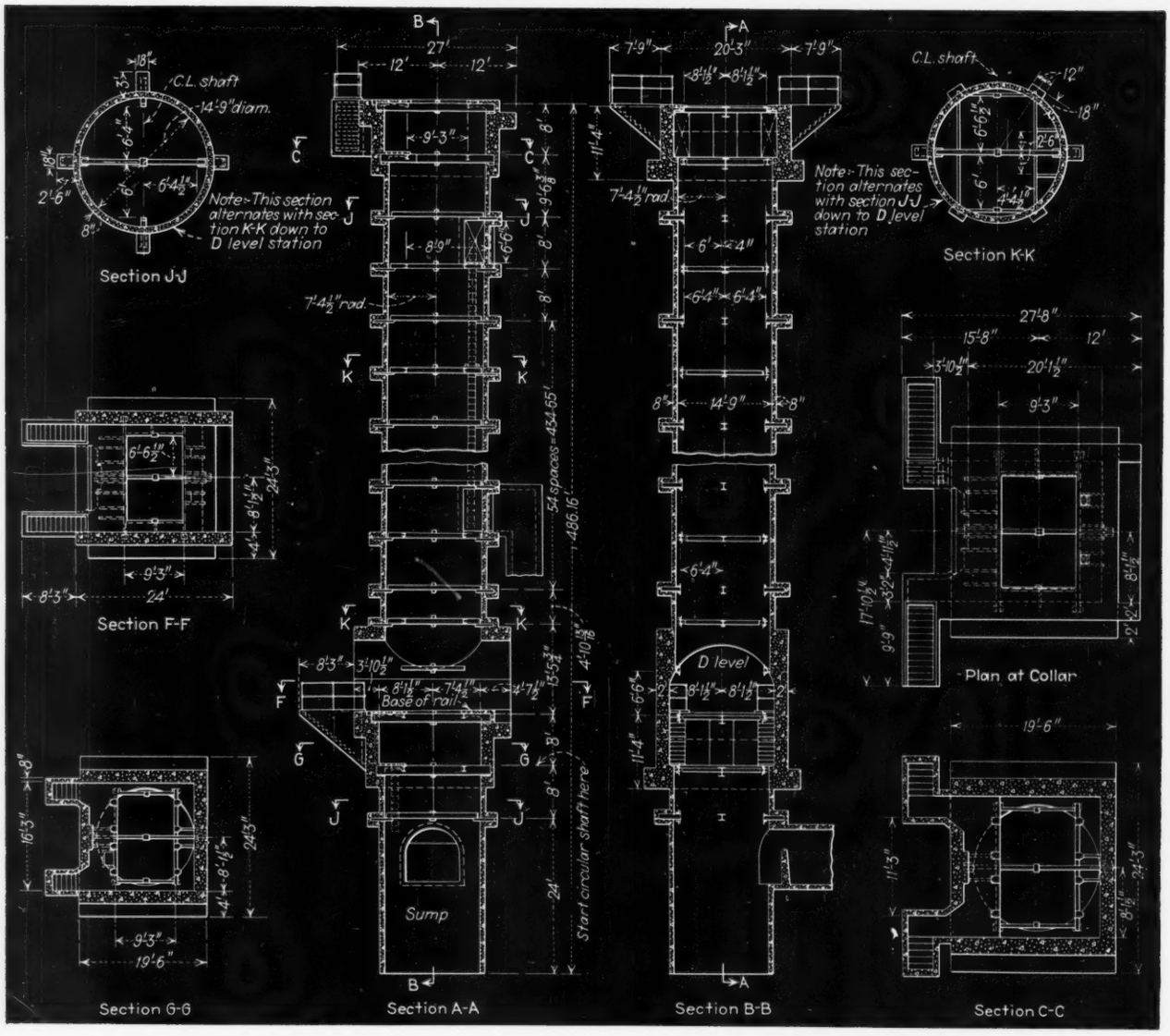
F. K. McIntosh

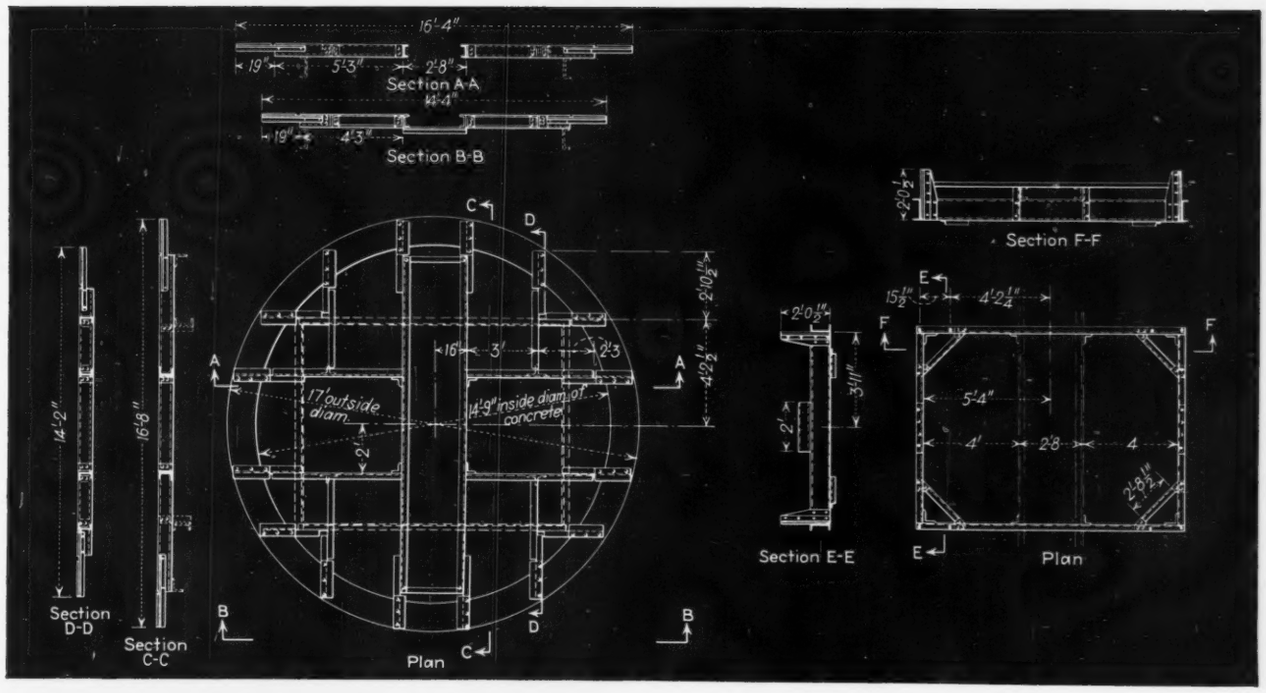
Cyprus Mines Corporation, Skouriotissa, Cyprus

RECENTLY, the Cyprus Mines Corporation, operating on the Island of Cyprus, in the Eastern Mediterranean, completed a 520-ft. vertical shaft of concrete and steel construction. It is of circular section, 14 ft. 9 in. in diameter inside the concrete and having two hoisting compartments, each 6 ft. by 8 ft. 9 in. in the clear, and a ladderway and pipe compartment. The only timber in the finished job is the $5\frac{1}{2}$x$5\frac{1}{2}$-in. guides.

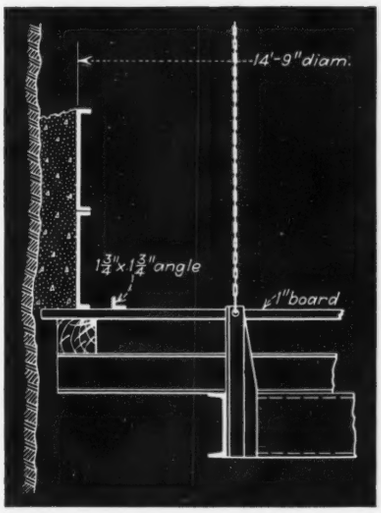
Formerly in other similar shafts it had been the practice to excavate the distance required for a pour and place the forms so they rested on the shaft bottom. As the time factor was important in this case, it was deemed advisable to arrange the work so that the mucking was not interrupted by the concrete work. To do this a bulkhead was built of steel members supporting a 3-in. wooden floor, fitted with a door that permitted the bucket to pass. This was hung from the shaft sets by four 5-ton chain blocks. This platform was at all times under the concreted part of the shaft and had a diameter 6 in. greater than the inside diameter of the finished shaft. Steel members supported sixteen 6x6-in. timbers on the perimeter. A $1\frac{3}{4}$x$1\frac{3}{4}$-in. angle rolled to a diameter of 13 ft. 9 in. was bolted to the top of the bulkhead, washers being

CONCRETED SHAFT of Cyprus Mines Corporation in vertical section. Variations in horizontal section from collar to sump are also illustrated





STEEL SINKING PLATFORM used in concreting shaft while mucking. Both upper and lower frames are shown



SUPPORT for the concrete while pouring the rings was supplied in the manner indicated. The boards were pushed under the 1¾x1¾-in. angle and over the timbers until they pressed against the rock and were wedged in place

LIP FORMS were made by welding in a lip (dotted line) extending 8 in. above the original top of the form (solid line) as indicated

introduced between the angle and bulkhead, so a 1½-in. space was left. One-inch boards about 3 ft. long were pushed under this ring and over the 6x6's until they pressed against the rock and were wedged in place. These boards served as a base on which to pour the concrete.

The forms used for the inner surface of the shaft were flanged, corrugated sections of pressed steel, 36 in. on the arc and 16 in. high, having three ¾-in. bolt holes on the ends and four on each side. Fifteen and one-half forms constituted a full ring giving a diameter of 14 ft. 9 in. Three rings were generally poured at one time, the steel shaft sets being placed in the middle ring.

A 5-cu.ft. concrete mixer on surface prepared the concrete, which was dropped down a 6-in. pipe with offset boxes at 150-ft. intervals. Another offset box was carried a short distance above the bulkhead, and from this the concrete was conveyed to the lip forms by a flexible pipe. The lip forms placed in the top ring of the pour were made by cutting out the upper central portion of a form and welding in a lip which extended 8 in. above the original top of the form. This not only acted as a chute to carry the concrete behind the forms but in completing the pour provided an 8-in. head, which, together with some vigorous puddling, insured a satisfactory joint.

When the mucking crew had made sufficient room, the bulkhead was lowered by the chain blocks about 4 ft., where it was centered by means of three radial arms sliding in guides, the outer ends pressing against the rock, the inner ends wedged against a central block. The 1-in. boards were placed in position and the forms bolted in place. Next the forms were centered and blocked to the angle ring. The bulkhead was then brought up snugly against the bottoms of the forms. Steel was lowered, hung by templets from the set above, lined, and blocked. From two and one-half to three hours was needed to make the pour. Six hours later the lip forms were taken off, the other forms being removed when needed below. As sets were placed at 8-ft. intervals, they fell only in alternate pours. No sagging or settling of the concrete was noted when quick-setting cement was used.

Approximately 30 per cent of the shaft was in caving ground that made timbering below the bulkhead necessary. Vertical breast boards were used as supports, the upper ends either being set in hitches cut outside the concrete or blocked to the bulkhead. When the ground was reasonably firm, the lower ends of the boards were let into a narrow trench about the perimeter of the shaft and blocked back to permit mucking to proceed in the center. When this was not practical, a horizontal square set was put in lying on the bottom of the shaft and the lower ends of the boards were blocked to it. After the pour the set was moved down or another one placed below it.

Two 16-cu.ft. buckets were used for mucking, one being filled while the other was being hoisted. The only time mucking was interrupted was when steel was being lowered and for about an hour every fourth pour when a templet was placed across the hoisting compartment to support a guide hanger while it was being blocked.

Light chains hung from the outer edge of the bulkhead served to guide the mucking crew so there would be no undue overbreak.

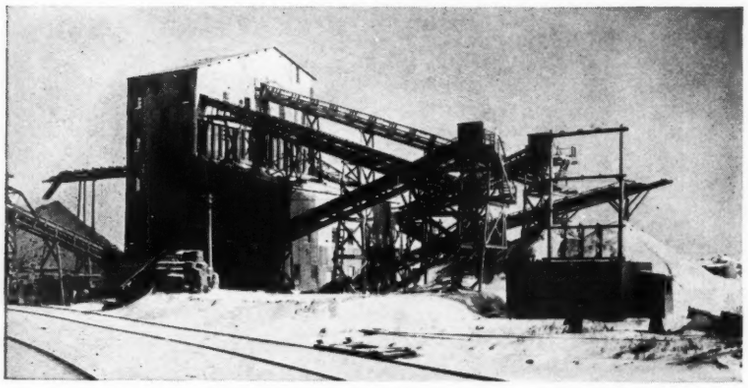
Judd Pit on Western Mesabi

Exhibits Current Trends

Equipped with truck-conveyor transport and with washing and jigging plant, it awaits start of 1938 season

Charles H. Remer

General Superintendent
Charleson Iron Mining Company
Hibbing, Minn.



THE JUDD BENEFICIATION PLANT—a winter view. Started by the Charleson Iron Mining Company at the end of the 1937 season, it is the newest of the Lake Superior Iron Country installations for beneficiating iron ore.

EARLY IN 1937 the Charleson Iron Mining Company leased the Judd property, near Taconite, Minn., on the western end of the Mesabi range. This had been stripped, and the better grade of wash ore in the top part of the orebody had been mined and hauled out by locomotive and cars to a washing plant about 10 miles away. Operations had ceased in 1925, since when the mine had been idle.

Tests showed that some of the remaining ore could be beneficiated by washing (scrubbing and classifying); and that the banded hematite and partly decomposed taconite could be concentrated by a combination of washing and jigging. A cheap method of mining and transporting the ore to the plant had to be used, inasmuch as the recovery was only 35 to 40 per cent of the low-grade crude ore, which ran 30 to 35 per cent in iron.

The company decided to erect a washing and jigging plant near the pit and to install a conveyor from a centrally located part of the pit floor to the plant. For the latter, a steel building used at another property was torn down and re-erected at the Judd mine. The conveyor system was built and a tailings pond was made on the north side of the old Judd stripping dumps, a half mile away. The plant was in operation during the last month of the 1937 season. It is designed to handle 300 long tons of crude ore per hour. A small tonnage was put through to find what adjustments were necessary and what changes would have to be made in the metallurgy.

In the pit the ore is drilled by a Bucyrus-Armstrong drill using 6-in. bits. The holes are loaded with 5x16-in. 25 per cent gelatin and are shot without being sprung. Being mostly decomposed taconite, the ore requires only a slight shaking up to permit economical shovel loading. This is done by a 1¾-cu.yd. Marion diesel-electric shovel into 10-ton Clyde trucks. Any rock or large pieces of ore that can pass through the dipper are loaded with the rest. Thus far the ore has broken small enough to make secondary blasting unnecessary.

The Clyde trucks have four speeds in either direction. The driver's seat is in the open on one side and can be turned through a half-circle. Trucks are run forward and backward between the shovel and ore pocket without being turned around. Two are used on hauls that are as much as 800 ft. in length. They can deliver 300 tons of crude ore per hour to the pocket at this length of haul.

The ore is dumped by the trucks into a pocket in the pit floor. From this it is delivered to a Robbins 5x12-ft. reciprocating feeder (1, in the flowsheet) 40 ft. below the floor. From the feeder it passes over a short bar grizzly, the oversize dropping into a 36x48-in. Allis-Chalmers jaw crusher (2) set to 5 in. The undersize and the crusher product go to a 30-in. conveyor (3). This has a vertical curve at the bottom to save headroom in the underground crusher house, as shown in the flowsheet. Its head end is at the elevation of the pit floor 60 ft. above the crusher-house floor. Here it delivers the ore to another 30-in. convevor (4), which is built in the open and runs through a cut made in the ore bank and the overburden. Conveyor 5 is built on the surface and elevates the ore to the top of the plant. It is equipped with a Merrick Weightometer, which weighs all the crude ore that comes out of the pit. These three conveyors have a total lift of 200 ft., a total length of 800 ft., and run at 360 ft. per minute. All are 30-in. belts and are powered by Westinghouse gear-motors with a final chain drive. All are electrically interlocked for starting and stopping. Conveyors 3 and 4 are inclined to a slope of 34 ft. in 100 ft., and conveyor 5 at a slope of 20 ft. in 100 ft. Conveyor 5 is equipped with a Ding's magnetic head pulley to catch tramp iron. All conveyor equipment is of Robbins make.

At the plant the crude ore is discharged on to a 6x12-ft. Robbins double-deck screen (6). The oversize from the top deck (3½x5 in.) is taken to waste by conveyor 7. Should this material be high enough in grade it can be put through the plant by setting the jaw crusher in the pit to 3 in. Oversize from the bottom deck (½ in. square) goes to a 4-ft. Symons Short Head crusher (8).

The minus-½-in. crude ore now goes to a 25-ft. Allis-Chalmers log washer (12) and is treated as wash ore most of the time. The concentrate or scrubbed material from the log washer goes to a 4x6-ft. Allis-Chalmers low-head screen (13). This screen has a single deck with a ¼-in. square opening. Oversize from it is taken by conveyor belt 16 to the concentrate bin (17).

The plus-½-in. crude ore that goes to the Symons crusher generally constitutes the jig feed. The Short Head crusher is in closed circuit with two 5x12-ft. Allis-Chalmers single-deck screens having screen cloth with ½-in. square openings. Conveyors 9 and 10 carry the crusher product to these

screens, where any oversize flows back to the crusher by gravity.

Following the screening on these two 5 x 12-ft. screens, any one of three methods of concentration can be used. First, the minus-½-in. material can be laundered to the Akins spiral classifier (15), and then into the jig circuit. Second, it can be laundered to the log washer and treated as wash ore. Third, the screen and crusher circuit can be opened by passing the oversize of the Allis-Chalmers screens direct to the log washer. This third method can be used only when the screen product is an easy wash ore.

Overflow from the log washer contains pieces up to 4 mesh in size and is laundered to a large Dorr classifier (14) to classify this overflow to 80 mesh. Classifier overflow is sent to waste, as it contains only 15 per cent iron or less, and is too fine for concentrating without being sintered. The rake product is laundered to the Akins for further scrubbing and classifying. The Akins overflow of minus-65 mesh is also wasted. Akins sands product, which includes the undersize from the low-head screen, the rake product from the Dorr classifier, and the minus-½-in. material from the 5x12-ft. Allis-Chalmers screens, if this be jig material, can either go to the jig bin or it may be bypassed to the concentrate belt.

When the product of the spiral classifier is to be jigged, it is carried up to the jig bin by conveyors 18 and 19. This holds 400 long tons of iron ore, and is situated in the building between the washing department and the jig department.

The jig plant is on one side of the jig bin, the jigs being fed directly from the bin by gates which can be raised or lowered to regulate the amount of feed. Two steel plunger-type three-cell jigs (20), with Star gates and bucket elevators, were used last fall. A third jig of this type will be added before the 1938 season starts, and a fourth jig, if necessary, to get the capacity needed. No middling circuit was used in 1937, but one will be put in for the coming season.

Several methods are being considered for recrushing the product of the third cells of the jigs. The crushed middlings will be put back into the same jig circuit.

Jig concentrate goes to a concentrate-dewatering belt drag (21) and then to conveyor 22, which discharges on to the main concentrate conveyor (16). The jig tailings go to a belt dewatering drag (23) and then to an 18-in. conveyor (24), which stacks them.

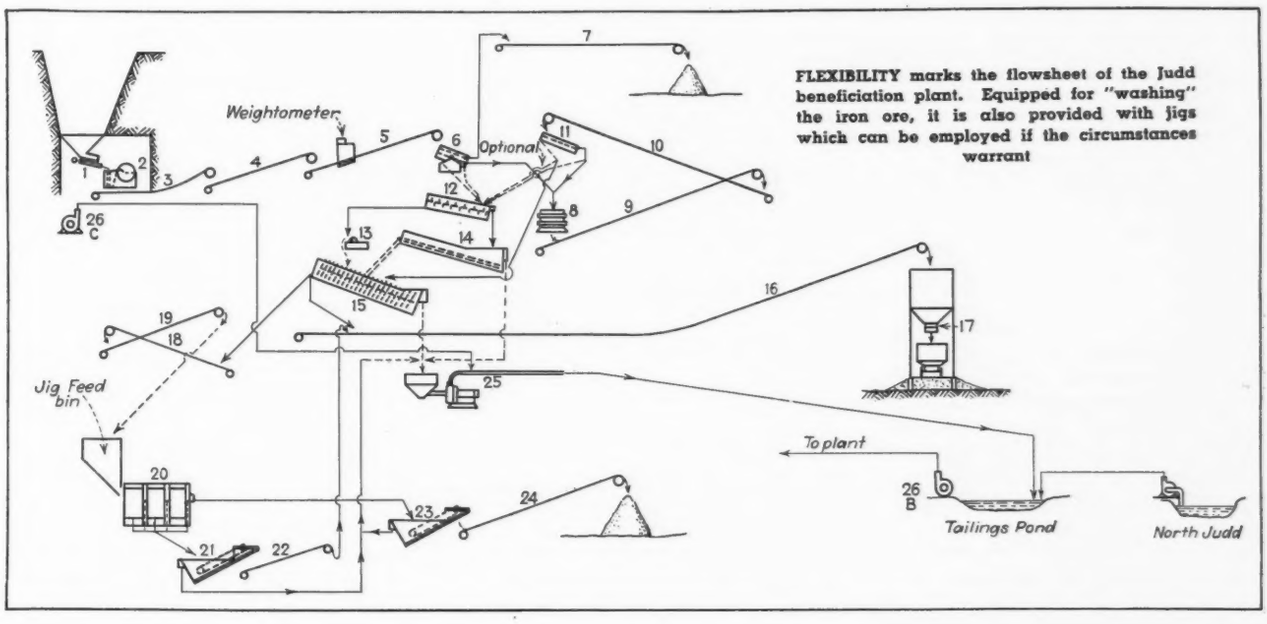
Overflows from the Dorr and Akins classifiers and the dewatering drags go to a sand pump (25) of 2,000 g.p.m. capacity, and are pumped to the tailings pond 2,000 ft. away. Clean water is pumped to the plant from the other end of the pond by a 2,200-gal. clean-water pump (26B).

Pump 26C, shown in the flowsheet, is the pit drainage pump which is situated in the underground crusher house in the pit. It helps supply make-up water for the tailings pond. Pump 26A in the North Judd pit also pumps into the tailings pond to supply water when needed.

All the conveyors are driven by gear motors with final chain drive, and run at 360 ft. per minute, except rock conveyor 7, which runs at 200 ft. p. m.

Crusher-circuit conveyors 9 and 10, jig-circuit conveyors 18 and 19, rock conveyor 7, and concentrate conveyor 16 are all 24-in. belts. Jig-tailing conveyor 24 and jig-concentrates conveyor 22 are 18-in. belts. All the inclined conveyors have ratchet hold-backs to hold them in case of power failure.

Total electric power used by the plant, pumps, pit conveyors, pit crusher, and feeder is about 800 hp. under full load.



FLEXIBILITY marks the flowsheet of the Judd beneficiation plant. Equipped for "washing" the iron ore, it is also provided with jigs which can be employed if the circumstances warrant

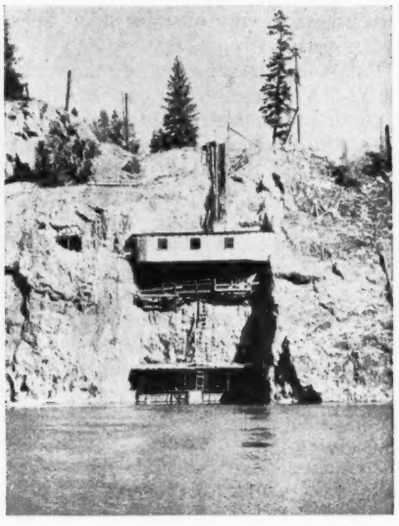
LEGEND

1. Reciprocating feeder
2. Jaw crusher
3. Crude-ore conveyor
4. Crude-ore conveyor
5. Crude-ore conveyor
6. Double-deck Robbins scalping screen
7. Rock conveyor
8. Symons crusher
9. Crusher circulating conveyor 1
10. Crusher circulating conveyor 2
11. 2 Allis-Chalmers single-deck screens
12. Log washer
13. Allis-Chalmers low-head screen
14. Dorr classifier
15. Akins classifier
16. Concentrate conveyor
17. 2 rack-and-pinion gates on concentrate bin
18. Jig-feed conveyor
19. Jig-feed conveyor
20. 2 ore-reclamation jigs
21. Concentrate-dewatering drag
22. Jig-concentrate conveyor
23. Tailings-dewatering drag
24. Jig-tailings conveyor
25. Sand pump
26. Fresh-water pumps

A New Change House for Wenonah Mine

THE Tennessee Coal, Iron & Railroad Company plans to provide additional change house facilities at its Wenonah ore mine No. 9, in the Birmingham district, Alabama. The new building will be 50 ft. wide by 106 ft. long and will have the latest type of ventilating and heating systems. It will be equipped with 364 overhead lockers for white employees and 216 for colored employees. There will be 28 showers in the white section and 16 in the colored section. The building will be of steel superstructure, with the roof, walls and ceiling of sheet steel.

POWER PLANT and substation at Metaline Falls, Wash., built by Pend Oreille Mines & Metals Company to supply its needs. The company was formerly served by the hydro-electric plant of the Lehigh Portland Cement Company, in the background



HEAD GATES of the new power plant above the Falls. The diversion tunnel, 12x20 ft. in cross-section, was driven in two sections—one half as a 12x20-ft. heading, and the remaining half by "side-swiping" or slabbing, as described in the text

Pend Oreille

Solves Power Problem in Unique Manner

New Metaline Falls plant is practically submerged during high-water season

Charles A. R. Lambly

General Superintendent, Pend Oreille Mines & Metals Company, Metaline Falls, Wash.

BEFORE the installation of the hydro-electric plant on the Clark Fork River at Metaline Falls, Wash., electric power for the operations of Pend Oreille Mines & Metals Company was obtained from a 3,600-kva. power plant maintained on Sullivan Creek by the Lehigh Portland Cement Company. The power requirement of this concern at peak load is about 1,800 hp., thus leaving for outside use a maximum of 1,500 hp. under normal water conditions. Until late in 1935 this was sufficient for all mining is the district. However, when the Pend Oreille company embarked in 1936 on a program of expansion, involving increased development at the mine and construction of a 300-ton flotation mill, and the Lehigh Portland Cement Company was operating at full capacity to fill a contract for Grand Coulee dam, the continuance of an adequate and continuous supply of electric power for the Pend Oreille operations became increasingly problematical. Moreover, the 2-mile flume at the Sullivan Creek plant developed several bad leaks during the high-water season in 1936, which resulted in a reduced flow of water to the turbines and consequent lower power output.

Mindful of these facts, and planning an early increase in mine production, the management finally decided to build its own power plant. Accordingly, a study of power sites available in the district was begun. The two principal essentials looked for were: (1) A site that could be developed during the low-water season, or in less than twelve months, and (2) nearness to the mining properly, to avoid long and costly transmission lines. A site that met these requirements and also offered the advantage of being developed without construction of a costly dam was found at Metaline Falls on the Clark Fork River, about one mile from the mine. Tests indicated that about 2 hp. could be generated for each second-foot of water. As built, the project involved diversion of water from the Clark Fork River above the Falls through a tunnel 700 ft. long to a point about 25 ft. below the crest of the Falls, and construction of the power house proper.

In September, 1936, when the project was first conceived, temporary plans were drawn up and estimates made for a 10x12-ft. tunnel and a power house with a 2,250-kva. generating unit, costing $250,000. Designs were submitted for study and approval to several consulting engineers, and applications for necessary building permits were simultaneously sent to the State authorities. Permits were granted in December, 1936, and work on the tunnel began at once. All construction had to be adjusted to prevailing water conditions; that is, the head gates above the Falls, power house proper, and the tail gates below the Falls had to be installed within a period of four months, or by April 1, 1937, when the high-water season begins. Any delay meant being flooded out and the suspension of operations until September, 1937. To date, the river has not receded to a point where construction could be carried on, so if plans to finish by that date had failed more than a year would have been lost.

Early in January, 1937, the orginal plans were changed to double the size

of the tunnel and the power house, thereby making possible installation of a second 2,250-kva. generating unit at an extra cost of about $100,000. On Feb. 1, when the 12x20-ft. tunnel had attained a length of 310 ft., work was stopped and excavation on the power house foundations was pushed with all available men and machinery. The pit was excavated some 27 ft. below low water, and the side facing the river was provided with a rock coffer dam to safeguard men and equipment in the pit. This dam was drilled and blasted after completion of the building.

The diversion tunnel was driven in an interesting manner. The 12 x 20-ft. heading was divided into two sections, each 12 ft. high and 10 ft. wide. On the heading section, as well as on the adjoining "side swipe" section, there was employed on a call-shift basis a full crew of machine men consisting of four miners, four chuckers, a shift boss, and a tool nipper. This arrangement offered the advantage of having the same crew work on the same heading every shift. Removal of broken rock was done by three mucking crews, each comprising an operator, one tender, and two men. These worked on a regular 8-hour shift basis. Tunnel work was carried on continuously. In other words, while the machine men would drill and blast in the regular heading, the mucking crew would remove broken rock from the side-swipe section, upon completion of which it would call in the drilling crew in the side-swipe section and start mucking in the regular heading. The average time required to complete a round in one section was 4 hours 42 minutes, or 9 hours 24 minutes for the full 12x20-ft. tunnel section. In the 12x10-ft. headings about 37 minutes were needed to prepare the face for drilling, and 2 hours 48 minutes to drill the face. Dismantling and removal of the drill set-up, and loading and wiring the round required 18 and 36 minutes respectively. Smoke and gas created after each blast were removed in about 23 minutes.

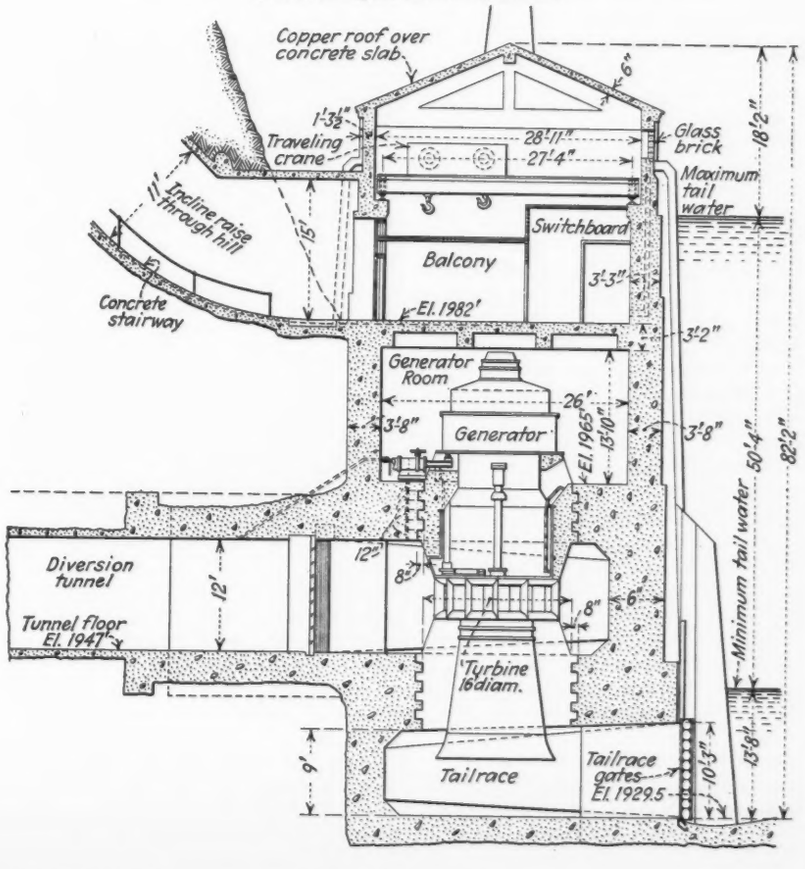
The drill set-up in each face consisted of two standard 4-in. drill columns 11 ft. long, placed about 16 in. apart in the center of the heading, and containing one arm near the top and another near the bottom. Drilling was done with four C.P. 60 automatic drifters, one serving each quarter of the face. The upper two machines were operated from a platform 6 ft. high. Average depth of ground drilled was 9 ft., and actual ground broken 8 ft. 9 in. In the side-swipe section fewer rounds were drilled, but the depth of ground drilled and broken averaged 12 ft. and 11 ft. 2 in. respectively. Broken rock in the headings was loaded into 2-ton cars by means of a 15-hp. Sullivan slusher hoist and scraper, which were removed in trains to the dump by a Plymouth locomotive. With the afore-described methods 305 ft. of regular heading and 264 ft. of side swipe were driven in eighteen days.

From the time tunnel operations were suspended—namely, Feb. 1, until Feb. 22, when laying of reinforcing steel was started—about 20,000 tons of rock was excavated for the power-house foundation. After 20 yd. of concrete had been poured on the first foundation, work had to be stopped, and for the following reason: With the advent of mild weather the rock cliff rising to a height of 126 ft. within a foot of vertical began to slough, endangering the men in the pit. It was necessary to station a man day and night on the coffer dam, whose only duty was to watch the cliff and call a warning to the men below whenever rock commenced to fall. This method proved satisfactory, as it gave the men working next to the cliff time to get out of the path of the falling rock. Concreting was resumed after nearly 500 tons of rock had been removed, and the damaged reinforcing steel was replaced. The first pour was made March 2, and by March 18 the building had attained a height of 44 ft., a point the steadily rising water would not reach until May 1. This work, which included concreting the tail race, tunnel floor, main water entrance, and generator floor, required about 130 tons of reinforcing steel and 3,600 cu.ft. of concrete. Next, the tail race gates were installed, and on April 1 the coffer dam cut in solid rock was drilled and blasted, which made it possible to continue work on the building during the high-water season. The building was completed April 30, the last pour being 108 ft. above the first foundation pour.

Gravel obtained from a bar in the river was treated in a screening plant situated 4 miles up the river from the power-house site. The finished products were stored in stockpiles next to the mixing plant on top of the cliff, with some 15,000 cu.yd. of material being moved, screened, and stored during January and February under subzero weather at a cost of $1.35 per yard. Concrete was mixed in a ½-cu.yd. mixer, which delivered a record output of 640 cu.yd. per 24 hours. The feed arrangement above the mixer comprised two chambers capable of holding 7 cu.ft. of sand and gravel, and one with a capacity of 2½ cu.ft. for cement. This gave a 7:7:2½ mix. The complete mixing cycle required 80 seconds: 10 for loading, 60 for mixing, and 10 for dumping. Mixed concrete was delivered to the foundations and wall through an adjustable 8-in. pipe.

The building proper was designed by G. Albin Pehrson, architect, Spokane, Wash., and is of reinforced-concrete construction. General construction features and layout of the generating units is explaining in Fig. 1. The building is rectangu-

A VERTICAL SECTION through the new power house and the 2,250-kva. hydro-electric generator



lar in shape, of modernistic design, with the outer walls in the turbine section measuring 6 ft. in width. Succeeding sections upward decrease to 3 ft. 8 in., 3 ft. 3 in., and 1 ft. 3½ in. As the building is practically submerged during the high-water season, great care had to be exercised in concreting operations to insure leak-proof walls and joints. The roof, too, is of reinforced concrete, 6 in. thick, and covered with copper. The difference between low-water and high-water levels is more than 50 ft., with the high-water mark about 12 ft. below the roof—a fact which explains the absence of any windows in the building except a 3-ft. section of glass brick 12 in. below the roof and extending the entire front and sides of the building. Entrance to the power house is afforded through an incline raise, 14x14 ft. in section, running from the balcony or operating floor to the surface. It contains a concrete stairway and a track system to lower or remove equipment from the power house whenever the need arises. So far, only one power-generating unit has been installed. It consists of a generator of Electrical Manufacturing Company make, and a modern Kaplan-type turbine made by the S. Morgan Smith Turbine Company. The sixteen gates of the speed ring are automatically controlled, and the blades of the turbine impeller are adjustable as to angle and pitch. At a speed of 180 r.p.m., the unit develops 2,250 kva. All control equipment—namely, the switchboard, governors, and other auxiliaries—is on the balcony floor, which is served by an electric traveling crane operating on 60-lb. rails. All pipes and cables leading to the substation on top of the cliff are poured in the concrete floor and walls of the building.

After completion of the power house, work was started on removing rock from behind the building for the tunnel entrance to the turbine impellers. These operations were both delicate and time-consuming, as they included light blasting to within 18 in. of the building and within 6 ft. of the water. Nearly 10,000 tons of material was removed in this work. Driving of the semicircular diversion tunnel was resumed next, and connection with the head gates installed before high water was made on Aug. 10. In the meantime, a surge tank 80 ft. long, 25 ft. wide, and 78 ft. deep was being excavated in solid rock at a point 100 ft. from the turbines. It contains no concrete lining, and its chief purpose is to stabilize starting and stopping operations. All material from the tunnel and surge tank excavations was removed by a belt conveyor passing through the power house wall near the roof and discharging 100 ft. down the river. While this work was in progress, erecting crews installed the generating equipment. On Sept. 5, when the unit was ready to be placed in operation and the tailrace gates were to be opened, it was found that both gates were jammed. To remedy the situation, a diver was called from Seattle, Wash., who found that the timber bulkheads placed between the gates and the rock coffer dam blasted out previously had collapsed, the loose timbers and débris rendering the gates inoperative. These were cleaned out, and on Sept. 9 the turbine was started on the dry run. When water was turned into the tunnel, leaks were expected to develop along the concrete joints above the roof and into the building. To date no leaks have appeared in any part of the building. The plant has been in operation continuously since last year.

The engineering staff and construction and rock foremen deserve much credit. Only one error appeared; that was the sinking of one part of the main pit 3 ft. below required elevation. In the concrete work not a single structure had to be changed, patched, or chiseled. The most noteworthy achievement was that not a single serious accident occurred during construction of the project.

Executive officers of Pend Oreille Mines & Metals Company are L. P. Larsen, president, and J. Jensen, secretary, to whom thanks are due for permission to publish this article. Members of the staff actively engaged in the construction of the power plant included E. Miller, engineer; F. Gaske, construction foreman; W. Curtis, rock foreman; and J. Currie, L. Kinney, and J. Lilies, engineers. The project was built on company time.

Xanthate Soap Flotation

(*Continued from page* 35)

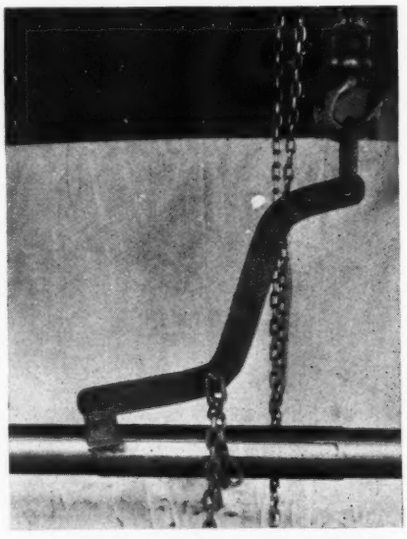
ash. With this treatment 74 per cent of the gold was recovered in a concentrate which contained 15 oz. per ton. In another test 1.0 lb. of amyl xanthate was added instead of 0.50 lb., and flotation was performed in the usual way. After the amyl xanthate concentrate had been collected, 0.10 lb. of oleic acid and 2.0 lb. of fuel oil were added to the amyl xanthate tailing and, without conditioning, an oleic acid concentrate was collected for five minutes. In this test 86 per cent of the gold was recovered in the amyl xanthate concentrate and an additional 11 per cent was recovered in the oleic acid scavenger concentrate. The amyl xanthate concentrate contained 21 oz. of gold and the oleic acid concentrate 1.3 oz. In practice, the latter material would, of course, be re-treated to improve its grade. Thus use of xanthate oleic acid flotation would recover considerable more gold at small expense.

This process has given good results on fresh amygdaloidal native copper ores and on three widely different partly oxidized ores. Thus it should also be applicable to other ores in which the valuable minerals are partly or completely oxidized or are finely disseminated or segregated in certain of the gangue minerals.

Grateful acknowledgment is made of the aid which the authors have received in this work. They are especially indebted to G. C. Dillman, president; to N. H. Manderfield, professor of metallurgy; and to C. T. Eddy, associate professor of metallurgy—all of the Michigan College of Mining and Technology. They are also indebted to the Copper Range Company for samples, valuable information on the problem, and the use of one of the units in the Freda mill for testing.

For Hoisting Pipe or Shafting

THE NEED for a better and safer method for handling pipe and shafting within the Leadwood shop of the St. Joseph Lead Company at Bonne Terre prompted Oliver Brown, machine shop foreman, to design a hoisting hook. The device is fastened to the pipe or shafting simply by passing the chain underneath and hooking it to the arm, as shown in the photograph. The hook-up should be made at the point where the proper balance will be attained to



keep the pipe in a horizontal position.

The length of pipe or shafting can be conveniently conveyed by the crane to the desired place in the shop, where the simple operation of unfastening the chain releases the hook.

Because of its simplicity the device has been found valuable on jobs where a large number of lengths of pipe must be handled individually for threading and cutting.

Valuation of Mines and Prospects

Under Present-day Conditions

Many properties are now worthy of reconsideration

Harrison Schmitt
Consulting Mining Geologist
Silver City, N. M.

EXAMINATION OF A MINE or prospect for economic purposes is a valuation or appraisal, although it may range from a cursory inspection of the property, or maps and data on the property, to a detailed time-consuming job that includes mapping, sampling, mining, and milling tests. Though much has been written on this subject, some comment seems appropriate, particularly the bearing of present-day conditions in mining on valuation. For one thing, developed or partly developed mines held at a reasonable price are becoming rare indeed, and valuation is more and more a matter of geologic probability; that is, the expectation, based on geology, of undiscovered ore and for any but well-developed mines, is a job for geologists and cooperating engineers or for specialists in geology with training in engineering.

Many appraisals of prospects and mines have become obsolete during the last decade through increased efficiency in mining, milling, and transportation. The most striking advances have been the near perfection of differential flotation, the improvement in motor-truck haulage to the point where for distances up to about 50 miles it is often cheaper than railroad haulage even for large tonnages, widespread betterment of roads, and perfection of underground mechanical aids, especially machinery for drilling, pumping, and handling ore. The effect of this progress, I believe, has not been fully discounted. Many properties neglected in the past, other things being equal, are now worthy of reexamination and reconsideration.

On the other hand, a factor which is increasing the costs of mining and making the risk much greater is social instability. When faced with the indubitably increasing danger to equities which this is bringing about, the average individual is likely to say that nothing can be done about it and that one must carry on as usual. Present political conditions, however, act as a break on the enterprise of thoughtful people. Taxes are reducing profits in all mining. The taxes of one mining company I know have increased 600 per cent since 1932.

Another factor which affects the value of small mines adversely is more difficult to appraise than the others, but it is none the less real. This is the widespread mismanagement of mines, particularly those under 500 tons' daily capacity. Many of the smaller mines have been mismanaged for a large part of their existence. The late Mark Requa used to repeat what a Cornish foreman once exclaimed to him, "To hell with a mine that won't stand mismanagement!" It seemed to Requa to be the expected condition and one he considered in valuations. One explanation is that most mining is not strictly a competitive business. Given a certain grade of ore, it is only necessary for profit that the cost per unit of metal at the point of sale be less than the market price. The marginal mines, marginal for reasons of grade, inaccessibility, difficult mining, or what not, are likely to be on a competitive basis. Their very existence indicates good management. Mines more favorably situated are likely to be mismanaged and to have high costs.

Metal Prices—Interest Rates

That the future price of metals is one of the important factors in the valuation of mines, but also one of the most uncertain, has always been understood. The tendency toward management of prices and production has certainly not decreased this uncertainty. The future short-pull price seems more and more dependent on political vagaries. Disregarding the possibilities of such national calamities as unlimited inflation or revolution or both—they appear to go hand in hand—we must fall back on the "law of compensation" to judge possible future prices. On the long pull, the prices of metals the production value of which is a large per cent of the national income are likely to seek a level based on supply and demand. We cannot expect political expediency to maintain forever unnaturally high prices, as, for example, for gold and silver.

The question of interest rates on money, which concerns amortization schedules among other things, is related to the supply of credit and unused savings, and this in turn, with political manipulations, has developed from a factor rather easily taken care of in mine valuation to one of considerable uncertainty. Savings today unless actively handled bring no or almost no return. Although eventually this condition will doubtless return to "normal," at present it presents a problem in amortization. Low interest rates coupled with excessive income-tax rates in the upper brackets have doubtless encouraged investment in mines. Whether this has been beneficial for all concerned will be learned in the future. Much money has been wasted on ill-advised projects. On the other hand, funds have been available for the prospecting which it is hoped will maintain the rate of discovery of new mines comparable with the rate of exhaustion of old ones.

In detail, of course, the methods used in appraising a prospect or mine vary with each assignment. The examination of a prospect will use methods

largely pointed to give information on the geology, whereas, in the examination of a mine, a larger proportion of the time and expense will be spent in sampling, assaying, and surveying. Between these extremes are all gradations of methods fitted to the various stages of development of properties.

Geologic Theory Applicable To Examination

The three principal geologic factors to be considered in the appraisal of a specific piece of ground are the amount of ground preparation, the intensity of the mineralization, and the replaceability of the wall rocks. I have suggested the term ground preparation to integrate the ore localization effects of different structural forms such as jointing, fracturing, faulting, and folding which cause breakings of various intensities up to brecciation and mylonitization. The channelways and the reservoirs thus formed provide space for the movements of fluids and the deposition of ore.

The intensity factor, which is the integration of the volume, time of passage, and replacing strength of the ore-depositing fluids, is equal in importance to the ground preparation factor. But either may in part supplement the other. Relatively weak ground preparation may be offset by relatively intense mineralization, and visa versa. The measure of the intensity factor is normally judged by the amount of wall-rock alteration and ore, but with a given intensity factor and given temperature of formation the amount of wall-rock alteration and ore will vary with the type of wall rock. For example, under high-temperature conditions (pyrometasomatic) the order of descending replaceability of wall rock by gangue minerals is about as follows: shale, shaly limestone and igneous rocks, limestone, quartzite, and sandstone; by ore minerals: limestone; shaly limestone and igneous rocks; shale, sandstone, and quartzite. At low temperatures changes in the foregoing sequences may occur. For gangue replacement the order is likely to be: igneous rocks, limestone, shale, sandstone, and quartzite; for ore replacement: igneous rocks and limestone, shale and sandstone, quartzite. The low-temperature order for ore and gangue minerals more nearly corresponds than for high temperature.

Many modifications and qualifications are bound up with these considerations. For example, in addition to the factors given, the order of deposition—that is, paragenesis of the minerals and reopenings of rocks—must be considered. The first phase of mineralization is usually the most intense and results in most of the wall-rock alteration effects. This is the time when in most deposits most of the silica is deposited either as quartz or silicates, depending on the temperature. But inasmuch as the deposition of minerals rapidly tends to choke the channelways, the appearance of the normally later sulphide stage is dependent on refracturing and refaulting—that is, reopening. In other words, we may have ample ground preparation and strong wall-rock alteration, but no associated ore. Again, a normally inhospitable shale may become a favorable host under special circumstances. It may be hornstonized by an early heat wave; then if shattered before the sulphide-stage, ore may fill the open spaces.

In one district the importance of a prospect is judged by the amount of gossan and wall-rock alteration; in another by the amount of fluorite and iron oxide in a quartz vein outcrop provided it is accompanied by increased widths of quartz; in a third the presence of barite; in another the presence of late fracturing and late quartz. This latter occurrence is a common type of favorable indication. The list could be greatly extended.

The final decision on a prospect from a geological point of view is usually based on the quantitative importance of some factor or factors measured in terms of developed mines in the same area. One is cautious and skeptical in a district which has been thoroughly prospected yet has no production record, but attacks with some optimism unexploited though well-mineralized areas in "new" countries recently made accessible, such as Siberia, Africa, and Canada.

Engineering and Other Considerations

Decision as to whether to recommend a given prospect for development, or for option and purchase, or either one, depends on many factors in addition to the geologic. There are the questions of price and terms, of engineering and other considerations such as power, water, labor, housing, timber, altitude and latitude, climate, metallurgy, possible methods of exploration, and of mining, taxes, and predatory political regimes. None of these is likely to be important enough to condemn a favorable prospect which may become valuable enough to justify building a railroad, piping in water, and importing labor. In other words, the geological probabilities may outweigh a consideration of the "weakest link" in the chain of factors. In appraising a developed mine, however, the consideration of the "weakest link" is likely to be critical.

The factor of accessibility for obvious reasons may outweigh any other in appraising a mine or prospect. A close second is the question of water, particularly where water is needed for ore dressing. The cost of labor, a function of both wages and efficiency, requires increasing consideration. Efficiency of labor varies inversely as government coddling, artificially increased scarcity through government-made work, unionization, and political conditions, national and local, permit labor groups to disregard the law. Housing is important if the prospect or mine is distant from a settlement, or if there is a shortage of housing in the settlement and neigboring towns, and houses and dormitories must be built, which increases the capital charge against the ore, although the universal ownership of automobiles in the last decade has of course modified this factor.

The Presence of Timber —Altitude

The presence of timber has obvious implications, but the usefulness of native timber in Mexico and the Southwest is limited. The effect of altitude on the efficiency of labor, air compressors, and internal-combustion engines is sometimes overlooked. Operating costs in extremely hot or cold climates are, of course, higher than the norm, particularly in times of prosperity when good staff men are scarce. The metallurgy of the ore of a prospect may be estimated, and in the case of a mine accurately determined. To estimate roughly the smelter value of various ores he encounters, the examining engineer or geologist should have adequate knowledge of metallurgy, ore dressing, and smelter schedules, and should have data on which types of ores and concentrates at what smelting charges are desired by the local smelters. Almost every ore smelted requires, of course, one or more complementary ores to balance it, and the demand varies from time to time.

Most sulphide ores, no matter how complex, it may be assumed, if not greatly affected by oxidation or supergene sulphidation, can be concentrated by modern flotation technique, except those rare ones whose texture is so fine that the minerals cannot be unlocked by "commercial" grinding the limit of which is, say, 75 per cent of the pulp through 300 mesh, but depends on the value of the ore. Even slightly oxidized or sulphidized mixed sulphide ores may be difficult to treat. Films of anglesite on galena ("sulphated galena") may make a a difficult ore, although they can be sulphided with sodium sulphide or removed with sodium hydroxide. Possibly the most difficul mixed sulphide ore is one in which the zinc particles are coated with covellite and chalcocite and water-soluble copper minerals are present, which makes the zinc sulphide float before its time. The copper and lead concentrates are then contaminated.

A fact to be mentioned in passing is that to make the most of smelter schedules modern flotation technique

can usually vary the iron, sulphur, lime, and silica content and the grade of a concentrate. Direct costs of milling may vary from $0.30 a ton on simple ores or for large-scale operations to, say, $6 on difficult ores and for a small scale of operation. Many mills are of 200 to 300 tons' daily capacity, and where concentrating base-metal ores by flotation usually show a direct cost which varies from $1 to $3 per ton.

Methods available for exploration and development of a given prospect or mine must be weighed and probable costs estimated. The modern tools for exploration include conventional heading development, precise geological mapping, diamond drilling, "deep-hole" hammer-drill drilling, churn drilling, shot-drill core drilling, and, on definitely restricted problems, geophysical prospecting. The costs are affected by the character of the ground, size and type of the orebodies, available contractors, and labor skilled in the various methods and amount of work to be done. The effectiveness of a given method or methods is, however, usually given first consideration. For large orebodies at shallow depth where the ground is not too hard, churn drilling appears to be the best means of exploration, as, for example, in "porphyry" copper deposits. The direct costs, including supervision, vary from $0.75 to $5 a foot, depending on the depth drilled and whether or not casing must be used to prevent contamination of the sludge samples, although the casing usually may be recovered. The average cost down to 200 ft. is about $2 per foot.

Diamond drilling is at its best in hard ground, and the direct costs vary from about $0.75 a foot for short holes in limestone where little cementing is necessary to $5 a foot for long holes or where an excessive amount of cementing or casing is necessary. The average is about $3 a foot. Holes may be drilled at any angle up or down. Up holes are difficult where much cementing is necessary.

"Deep-hole" hammer drills are effective in ground too soft for diamond drilling for depths up to 200 ft. They can also be used in moderately hard ground. Stellited bits make the method more efficient. Direct costs may be as low as $0.30 per foot and are seldom higher than $2; the average is about $1.25. Holes can be drilled at any angle, but the most efficient ones and the ones largely used are between 5 and 50 deg. above the horizontal.

Chief reliance in exploration, of course, is placed on conventional heading development by drifts, crosscuts, raises, shafts, and winzes. One of the most critical decisions in an appraisal is the probable type and size of shaft needed and its probable cost. The aversion of some engineers to inclined shafts borders on fanaticism. Although the cost of operating them may be greater, inclined shafts are in many cases the correct mode of entry[1] because the ultimate cost per ton of ore may be less. Often it is the most economical mode of entry for preliminary exploration. When the size, character, and other features of the ore are known, a vertical shaft may be indicated and the original shaft then used as an escapeway, air-way, or timber-way. The direct costs of shafts vary from $20 a foot for shallow untimbered shafts to $500 a foot for large, deep shafts, particularly where large volumes of water are encountered in sinking or where concrete linings are used. The average direct cost of a three-compartment shaft to 1,000 ft. in depth for an average mine of, say, 500 tons' daily capacity is about $100 a foot. If water is encountered up to several hundred gallons a minute, the cost may exceed $200 a foot. The direct costs for other types of development per foot under normal conditions are about as follows: Drifts and crosscuts, $5 to $18, average $10; raises (not over 100 ft. high) $4 to $15, average $8; winzes (not over 100 ft. deep) $15 to $30, average $25.

Other Development Costs —Stoping Method

Cost per ton of heading development for exploration usually varies as the profit made per ton of ore. With large profits it is generally worth while to carry on more development footage than where profits are small. It is difficult to set an average cost, which in base-metal mines may vary from $0.10 per ton in low-grade ores to $3 a ton in ores of higher grade.

The cost per ton of development for dead work may not be closely related to the grade of the ore. Certain work must be done regardless of grade to get at the ore and prepare it for stoping. On the other hand, when high-grade ores are being exploited it pays to do more than an ordinary amount of dead work to extract small masses, or pillars, or narrow veins.

Determination of the method of stoping likely to be used requires an integration of both wide experience in mining and geologic knowledge. Stoping costs show wide variations from mine to mine. The geologic picture should give some idea of the character of the walls and ore and the distribution, width, and height of the ore. Knowing these things, particularly how much support is needed, a stoping method is selected which gives the lowest cost with adequate safety. The mining business has not escaped fads. For example, in recent years there has been a tendency to use shrinkage stoping wherever possible on many ores with good walls where cheaper methods such as milling and sublevel caving would serve as well. Direct costs of stoping may vary from $0.25 a ton for large-scale mining to $5 or more a ton for selective mining. The costs for mines of moderate size producing 200 to 300 tons daily, and using stoping methods varying from shrinkage and milling to square-set, will varly from $0.75 to $4 per ton of ore.

A fallacy still persisting even among graduate mining engineers is that one is justified in diluting high-grade ore with material which, by itself, will not pay its way. Parenthetically, this is discounting the credit which may be given to marginal ore because of an already established plant, development work, and like factors, for it is obvious that once a plant is built on the basis of blocked-out and anticipated ore, additional ore found need not carry the capital part of the overhead and lower-grade ore may be mined. Based on the same reasoning, if the necessary dead work, drifts, raises, and chutes for a stope on an orebody have been established, unanticipated ore, usually marginal ore in the walls, may be extracted without charging the original dead work against it. All this considered, there is still no economic justification for mining ore which will not carry at least the direct charges of breaking, tramming, hoisting, hauling, and milling. This simple truth seems to have wholly escaped many operators, partly because they compute their costs on a per-ton basis and are fascinated by the effect of increased tonnage upon overhead per ton, and because they are seldom directly connected with milling and pay little or no attention to the cost per unit of metal. In other words, a high rate of production is desirable if it is not accomplished by mining submarginal ore and waste. The obvious remedy is to insist that costs be calculated on a per unit of metal basis which integrates into costs the effect of grade and rate of production. The examining engineer may find it impracticable to calculate probable cost in this way, but he should safeguard his client by pointing out the difficulties mentioned in the foregoing and the remedies.

The question of power for a prospect or new mine where no public service power is available is a major problem and expense because modern mechanization has greatly increased the ratio of unit of power to unit of production. For mines of small to average size the diesel engine has superseded most other types of power sources and has greatly reduced costs per unit of power. The improvement in these engines during the last decade

[1] Hoover, H.: "The Principles of Mining." McGraw-Hill Book Company, Inc., New York. Pp. 58–73, 1909.

has dropped the weight per horsepower from 250 to 50 lb. in certain makes of engines. Diesel power when the plant is amortized at average rates costs between 5.0 to 15.0 mills per kilowatt-hour under average conditions. Many newly equipped small mines do not have enough power, are continually handicapped, and have therefore disproportionate costs.

A mine or prospect may be worthy of option or purchase in all respects but those of price and terms. An examining engineer has often been criticized because he turned down a property that later became a profitable mine. It may have been that the terms were too hard to justify the risk. The layman thinks of an undeveloped prospect in the same terms as real estate; that is, with a more or less fixed value. Needless to say, a prospect or undeveloped mine has only a speculative value; its true value must be determined by development. Except under special conditions an owner cannot fairly expect a cash payment for an option to purchase. Generally he must give a free option to purchase at a price, but he justly may require a certain amount and rate of expenditure of money for development. The agreement usually, in addition, takes the form of a lease during the period of the option, with the payment of royalties on average-grade ores of around 10 per cent of the net smelter returns on ore or concentrates to be applied on the price. This form of contract is a lease and option to purchase, usually misnamed a lease and bond in the West.

Appraisal Methods From Prospects to Mines

A method of examination which I think well of is essentially one that applies the conventional engineering factors plus what is here called precise geological mapping, which I have described in recent papers.[2] Precise geological mapping may be defined as mapping which on the surface and underground measures contacts, beds, faults, fractures, and the like with an exactness comparable to the usual measurement of mine openings. On the surface a plane table is used and distances and elevations are accurately measured with stadia using a scale of mapping of not less than 200 ft. to the inch and usually not less than 100 ft. to the inch, depending on the geological conditions. Sufficient stadia shots are taken so that an accurate topographic map can be assembled along with the geological data. Underground, a scale of not less than 40 ft. to the inch is used and contacts, faults, and related factors are measured to the nearest foot. The conventional method of mapping geology by sketching on a previously prepared topographic map has been found to be insufficiently accurate for closely controlled diamond drilling except where small-scale maps are adequate or where the geology is that of simple veins or blanket deposits or where there are relatively few outcrops.

Examination of a prospect follows a variable pattern. As a rule, one day, or at most four days, including office work, is sufficient for the work. A few samples may be cut and the geological setting determined. Every formal examination of a prospect for a mining company, or for an individual on a fee basis, should aim to compile diagrammatic records such as reconnaissance plane-table surveys, compass surveys of underground workings, and detail maps of the underground geology. Such records obviate the need of many reexaminations and permit others who have not seen the property to form an objective opinion. If the work is done for an individual client he should be furnished with maps and other diagrammatic material, along with the customary report in letter form. He may not see the need for such data at the time, but if the prospect has merit and the report does not appear to be biased the next approach to a prospective buyer will be facilitated.

The examination of properties ranging from partly developed prospects or mines to well-developed mines is in part the extension and intensification of the approach used for untouched prospects. If the surveying work is to be used as a basis for future development and mining, it may be worth while, and the client may desire to do a thorough job, starting with the measurement of a base line, observation for meridian, triangulation, and underground transit surveys. Otherwise it may be feasible and more economical to orient the plane table by compass, measure a base line with a cloth tape or possibly stadia, and connect the surface control with the underground with a Brunton compass or a tripod. The latter instrument can also be used to survey the mine. It is advantageous to get the geological work well under way before sampling is started, because the detailed mapping defines the walls of the vein, shows crossings, branches, parallel veins, character of the vein and ore, and in short gives the information necessary to plan the sampling campaign.

A variety of questions to be answered include the best interval between samples, whether or not fraction sampling is needed, feasible method of stoping and therefore how much wall rock must be included in the sampling, the minimum amount of spoil per foot which must be taken on the sample cuts, parts of the vein obviously waste where no samples are needed, and parts of the vein in doubt where pilot samples should be cut first—that is, samples at intervals which are multiples of the normal interval selected so that intermediate samples may be cut if the first assays show the ground to be interesting. Under some circumstances, because of the supervision problem and the short time available, the sampling must start along with the other work. In such an event the geologist should start detailed mapping and study where the sampling is begun. He can soon lay out a good deal of ground in advance of the sampling.

When "Streak" Sampling Is Necessary

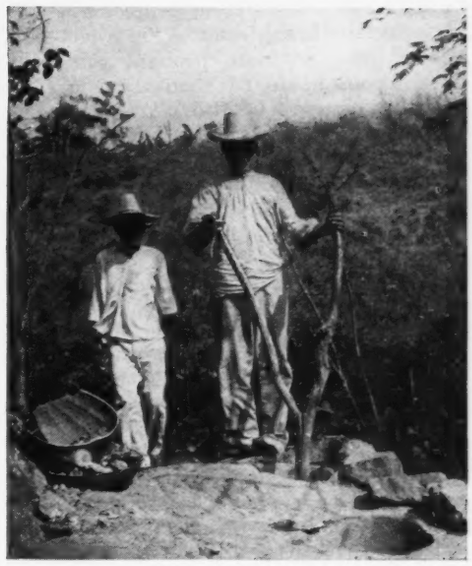
Fraction or "streak" sampling is necessary along veins, particularly where the walls, lenses of ore, and horses of waste cannot be defined by visual inspection and yet where the entire mass of vein cannot be mined profitably or where more profit can be made by selection. This type of sampling is done by breaking up a given sample cut into several parts each of which covers an interval which is of different visual and physical character normal to the plane of the vein. It is based on the principle that a difference in visual and physical properties in the vein usually means a difference in assay value. The fractions which assay above the minimum value for ore plus the waste streaks which must be mined with them because of the mechanics of stoping are aliquotly combined to one average, which, in turn, is averaged with the other similar averages of each cut on the oreshoot.

The intrinsic value of a mine, what could be paid for it were all the pertinent facts known, is not more than the possible net profit less the amortized investment needed for buildings, equipment, and development with interest during the period of investment return of not less than 7 per cent and usually 10 to 20 per cent or more. The difference must be further reduced by the interest expected on the price during the life of the mine. Actually, all the pertinent facts are seldom known and the intrinsic value can be approximated only.

Under present conditions of predatory attack on capital and danger to currency-measured securities such as bonds, savings, and life insurance, through inflationary tendencies, investments in equities such as mines which have a good chance of merely returning the capital with or without normal interest or even at a small loss may be attractive as a means of preserving capital.

[2] Schmitt, Harrison: "Cartography for Mining Geology." *Ec. Geol.* Vol. 27, pp. 716–35, 1932. Also "On Mapping Underground Geology." *E. & M. J.* pp. 557–61, Nov., 1936.

A PROSPECTOR'S CAMP in Honduras. In this country there is an almost continuous area of mineralization, in different parts of which much work has been done



CRUDE-ORE TREATMENT in El Salvador. A native *molineta* in the Santa Rosa district. The greatest mineral development in this Republic centers around San Miguel

Central America

Aspects That Present Themselves To a Visiting Engineer

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ACCESS to Central America is easy. Unless one travels by air, however, considerable time is necessary for the trip. Entry to each of the republics, except El Salvador, can be made from either the Atlantic or the Pacific sides by steamship. Weekly sailings are made from New Orleans and other Gulf ports to points on the north coast of each country, again excepting El Salvador. On the Pacific side many of the steamship lines stop at ports in all the countries on frequent schedules. Caribbean ports are reached from New Orleans in four days, and the Pacific ports of Guatemala, Salvador, and Honduras may be reached from the West Coast of the United States in seven to ten days.

Honduras, with only one port, Amapala, on the Pacific, and not much traffic through that point, is hard to reach by direct steamer on that side. The more customary route from the West Coast of the United States is by steamer to La Libertad, in Salvador, and thence by plane to Tegucigalpa. This can be varied by taking a small coastwise steamer to Amapala, which is somewhat cheaper but takes much longer. An excellent air service is maintained to and between the various republics. If one travels thus, he can reach the capitals of any one of the five countries from most parts of the United States in three days.

Physiographically, Central America is what would be expected from the fact that the connecting link of mountains between the Sierras of Mexico and the Andes of South America passes through the entire length of the region. The general conception of "tropics" as being nothing but swamps and low-lying, malaria-infested plains is sadly out of place here. In going from north to south, or from the Atlantic to the Pacific, one crosses range after range with peaks rising to heights exceeding 8,000 ft. Climatically, extreme variations are to be found, largely dependent on comparative elevation above sea level. Someone has coined the phrase "vertical climate" and it well describes the conditions in Central America.

On the coasts is found a hot, humid climate, but as altitude is attained notably cooler conditions prevail. Humidity is high even at these greater elevations, but temperatures are little, if any, higher than in many parts of the southern and southwestern United States. When one gets 1,000 ft. or more above sea level, climatic conditions are pleasant.

Rainfall is heavy and spread over the greater part of the year. The rainy season is considered to be from May to December, although variations in this schedule occur in different parts of the area. In general, normal rainfall exceeds 100 in. a year in practically all parts of the region.

Ethnologically, the population is essentially a mixture of Spanish and Indian. Variation in types can be noted even on short acquaintance. Probably the greatest intermixture is in Honduras and Nicaragua.

As a rule, all of these peoples are hospitable. Latin courtesy is widespread, and no more pleasant companion can be found than the educated, cultured Central American. Among the wealthier, education has commonly been obtained already in England or the United States. Contacts thus made are revealed in many business affairs.

Spanish Essential

Spanish is in almost universal use, although the Castillian has been modified by native elements. In some sections the native dialects are still used, but only to a small extent. Knowledge of Spanish is essential for business contacts.

National pride is high. The foreigner coming into the region must be continually on his guard not to wound it. Such mistakes are of course equally out of place in any foreign country, but they are especially to be guarded against in Central America, where the small size of the countries sometimes leads to condescension on the part of unthinking visitors. Although the different countries of Central America nominally have republican forms of government, it can be said, briefly, that they are operating under individual dictatorships of varying degrees of severity. As regards the development of the mining industry by foreign capital, the present regimes are favorably inclined, provided that the interests back of a proposed new project are really interested in putting men to work and in opening up natural resources. All of the countries have suffered from the operations of promoters.

Laws and Concessions—Each of the Central American countries has its own mineral code, varying in detail but all similar in plan. Of chief interest to the potential operator are the provisions for free importation of mining equipment and supplies and the levying of a fixed tax on the export of mine products. A troublesome feature of the legal situation is the fact that each department or state in each of these countries, particularly Honduras, has its own rules and regulations regarding the import and export of material into and out of its individual area. In other words, each has its own tariff, independently of the Federal schedules.

Taxes on imports are based on gross weight. Because of the heavy packing sometimes necessary for ocean transport, this item may be severe. By proper planning with the forwarding agencies this handicap can usually be reduced.

Export taxes are subject to agreement at the time the concession is granted and may be based on the gross value of shipments of product or on the net profits of the enterprise. The latter arrangement is somewhat difficult to determine and may easily lead to dispute unless detailed and specific rules for its determination are early drawn up.

The "congressional" concession usually granted to foreign mining operators is advisable, as it protects them against the vagaries of succeeding Congresses. I know of no case in which such a concession has been repudiated or seriously altered to the disadvantage of the concessionaire, once it has been formally granted.

Transportation—This problem is perhaps the most serious one met. Handling of supplies and equipment is difficult and the mere moving of personnel is attended by inconvenience and sometimes hardship. Roads and highways suitable for any more ambitious means of travel than mule or ox cart are noticeably absent, except in areas close to the larger centers of population. New ones are being built in many parts of the different republics, but as a general thing those in authority have still to learn that maintenance is of as much importance as the original construction, if not of more.

The lowly ox and the ever-present friend of the miner and prospector, the mule, still are vital factors in the transportation picture of all these countries. There are innumerable parts of the entire area which can be reached only on foot or on the backs of animals.

Development of air travel has been rapid and has had a far-reaching effect on the back areas of all parts of Central America. It is safe to say that in all of them there are people who have traveled by airplane but who have never ridden in an automobile or on a railroad.

Each republic has its own locally controlled air-transportation company which flys on regular schedules to all parts of its particular country. These work harmoniously and cooperate in maintaining connecting schedules. Honduras, which offers the greatest obstacles to air transport, probably has the most complete coverage by regular air service of any of these countries.

Planes of all types and makes are used, from the freight-carrying Ford Trimotor down to the two-passenger open ship. To a stranger, one of the most striking features of this region is the matter-of-fact way in which the natives take to air travel for themselves or their belongings.

International transport is well cared for, by air, by the Pan American Airways as well as by the local companies. The time element is probably of most importance in this movement, which is well illustrated by the service between the cities of San Salvador and Tegucigalpa. This trip by air takes fifty minutes to an hour and fifteen minutes, depending on equipment used, whereas overland it requires from 24 to 48 hours, according to the time of year.

General Geology—Within the Central American area, along the Pacific Coast, from Guatemala south to Costa Rica, is one of the most active volcanic regions in the world. All the countries except Honduras have active volcanoes which smoke continually and at frequent intervals actually erupt. Recently there have been no serious eruptions.

Earthquakes are frequent and occasionally do much damage. That of December, 1936, which centered around the volcano of San Vicente, in El Salvador, almost completely destroyed the town of that name. No eruption occurred, however. All of these active or recently active volcanoes lie in a narrow belt close to the Pacific Coast, none that I know of being farther inland than 20 miles. In view of this vulcanism it is natural to expect numerous types of volcanic rock, both extrusive and intrusive. In close association with these fine-grained rocks are several of deeper-seated plutonic types.

A common error is the assumption that practically the entire area is composed of igneous formations. Although much of the surface is so covered, limestone, shale, sandstone, and similar rocks are also found. Quartzite is of common occurrence, although sometimes hard to distinguish.

Faults are numerous and some have had much effect on the mineral deposits. No comprehensive study has as yet been made of any appreciable area, and the examining engineer must make his own interpretation of conditions.

With the humid climate and heavy rainfall, erosion is rapid and weathering processes are effective to considerable depths. Add to this the rapid and dense growth of the tropical vegetation, and some of the difficulties of geological work and prospecting can easily be visualized.

Gold the Prospector's Incentive

Mineral Deposits—As might be anticipated, the development in the mining industry in Central America has been centered on that of gold. This is due of course to the greater value that can be obtained from small tonnages and concentrated into little bulk for transport. The old Spanish explorations were practically limited to gold. Part of the gold produced has come from quartz veins, but probably more has been produced from placers, largely by individual washing operations.

Nevertheless, the largest mining operation in Central America and the one carried on for the longest period

of time has been based on silver. This, of course, is the New York & Honduras Rosario enterprise at San Juancito, about 20 miles north of Tegucigalpa, Honduras, which has been working continuously for 55 years.

Enough work also has been done, rather sporadically, to show the presence of commercial deposits of copper, iron, lead, zinc, and antimony. Occurrences of other metals have been reported.

Mining Areas—It would be impossible to mention all the different districts in which mineral deposits have been found and on which some work has been done. Likewise, it is hard to generalize as to their distribution. It can be said, however, that almost the entire southern part of Honduras is mineralized and that prospecting of some sort has been carried on in many places. Most of this work has been primitive and sketchy, in most cases consisting of superficial cuts, trenches, and short tunnels. Localities in which any appreciable depth has been attained are rare, and the examining engineer is confronted with the problem of deciding whether the deposit shows sufficient promise, from surface indications, to justify the expense of even the most preliminary development.

In El Salvador the greatest development has centered in the region around the town of San Miguel, in the eastern part of the country. The real center of this work is closer to the small village of Divisadero, where the old Butters Divisadero and Butters Salvador companies operated for several years. Operations are still being conducted by several companies, some locally financed and some American.

Promising mineral showings are to be seen all along the border between Honduras and Salvador from the Gulf of Fonseca, on the southeast, to the Guatemala border on the northwest. Near the latter point are found deposits of zinc which may some day be of importance.

Mineralization in Honduras

In Honduras from the Gulf of Fonseca to Tegucigalpa there is an almost continuous area of mineralization, in different parts of which considerable work has been done. The centers of the more important developments are Aramencino, Pespire, Sabana Grande, and Lapaterique. Around Tegucigalpa itself centers a mineralized area from which considerable production has come. Fifty miles east of it is the district centering in the town of Danli, near which is the Agua Fria mine, a present-day producer of gold.

At San Juancito, previously mentioned as the site of the Rosario mine, are numerous other deposits of potential value, from one of which considerable production was secured at one time.

Further northeast is the Olancho district, centering in Juticalpa. From this district likewise has come much placer gold from the earliest days. Several small prospects are still being worked.

Comayagua, 50 miles northwest of Tegucigalpa, is another gold-silver district which has produced considerable wealth.

Farther north, around Yoro, and to the northwest, around Santa Barbara, are found indications of mineralization and old operations reported as being worth investigating. Here an English company has recently established itself.

Less is known about the conditions in Guatemala, but for several years a dredge has been operating on a river near the Honduras frontier. Also, in the extreme western part of the country, near the Mexican border, are found substantial deposits of lead with appreciable amounts of silver.

In Costa Rica, the mining activity seems to be centered in the State of Guanacaste, along the Pacific Coast in the northwest part of the country. Old reports indicate that there may still be interesting orebodies not developed by the operations of the past.

Nicaragua is in somewhat the same position as Honduras, in showing widespread mineralization but with comparatively little important development. The Butters interests at one time operated extensively in Nicaragua and attention is being paid at present to their properties.

Important work is getting under way in parts of Nicaragua and with continued quiet should lead to interesting discoveries.

Present Operating Mines—As has been mentioned, the New York & Honduras Rosario Mining Company is the outstanding operation in Central America. It is producing about 500 tons of ore a day. Recently it began development of a prospect on the Salvador border near Aramencino. It has also been working to reopen an old mine in Nicaragua in the last two years.

The Agua Fria mine has a 50-ton combination flotation-cyanide plant. Operations under the present control started in 1934. All transport is done by airplane.

Several groups are negotiating for properties or trying to clear up complicated tax matters. Some of these are apparently almost ready to begin development.

In Salvador, the Central American Mines Company, an American corporation, has been operating the Potosi mine, northwest of San Miguel, with a 50-ton cyanide mill. Bullion is shipped regularly by Pan American Airways.

The Monte Cristo, near Divisadero, Salvador, is operating a 30-ton cyanide mill and shipping bullion regularly to Europe. The old San Sebastian mine, formerly a Butters property, is producing 8 to 10 tons of ore per day. Recently a concession was granted by the Salvador Congress in the Santa Rosa district, north of Divisadero. It is not yet in production.

There are also several small groups in both Salvador and Honduras which are trying to finance themselves locally in order to reopen various old properties.

In Guatemala the only operation I know of at present is the dredging work, previously mentioned, close to the Honduras border.

Several small properties are said to be under development in Costa Rica, but the extent of the work done is unknown.

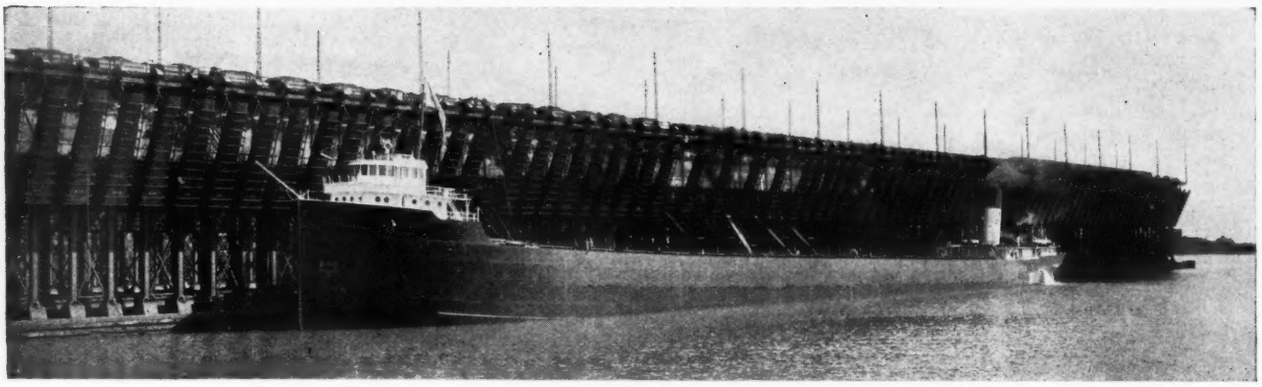
The Power Problem

Power Situation—Improvements in diesel engine design and operating efficiencies are already having a considerable effect on the problem of power production for the Central American mining industry. One of the handicaps in the past has been the lack of dependable, economical power. This has been met in different ways: at Rosario and Agua Fria, by installing hydro-electric plants; at Potosi, by diesel; and at Monte Cristo, by an inefficient steam plant. This latter is now to be replaced by diesel engines.

At only a few localities in Salvador and Honduras, and I believe the same holds true in the other countries, is there available a reliable source of water for hydro-electric power generation. Many of the streams will furnish sufficient water for power during the rainy season, but would be entirely inadequate during the dry period. Use of steam plants is almost out of the picture, especially in Salvador, due to the difficulty of securing an ample and steady supply of wood for fuel without an excessively long haul.

Labor Conditions—A substantial supply of labor is available for work around mines. Much of it is untrained in mining work. The men are willing to learn, however. An operating foreman must realize the limitations of the people and adapt himself, to a considerable extent, to the customs and habits of generations.

Normal wage scales in use are low when converted to American dollars, but likewise the efficiency of the men is far below that in this country. Actual wages range between one and three pesos (in reality the colon in Salvador, the lempira in Honduras, and the cordova in Nicaragua), which at the different exchanges amounts to from 40 to 50c. to a dollar or a dollar and a half.



AN ORE CARRIER at one of the Upper Lake Port docks, to which the output of the iron ranges is shipped by rail

Grading Lake Superior Iron Ores

Many factors must be considered to insure uniformity of cargoes

E. P. Bayer

Ore Grader, Mesabi Range Mines, Pickands, Mather & Co. Hibbing, Minn.

IN THE EARLY DAYS if iron mining on the Lake Superior ranges, and continuing through the years of the World War, ore grading consisted principally of separating bessemer from non-bessemer ores. Iron and phosphorus were the principal elements. If the mine operators delivered ore showing an iron content better than estimated or specified, along with lower phosphorus in the case of bessemer ores, premiums were collected and the job was considered satisfactory. Only comparatively high-grade ores found a ready market.

With the advent of special steels the close specifications the industry was required to meet worked back to the ore and the mines. Increasing demands were made for ore of uniform analysis, not only from cargo to cargo, but in each cargo itself. Silica, manganese, and, in recent years, alumina, became elements of prime importance. The situation had to be met with ores of lower grade than in the past, so that ore grading became a matter of larger scope with each passing year. At this time it includes control of car supply between mines; the orderly movement of loaded cars from mines to Upper Lake docks to meet vessel schedules; the assembling of the loaded cars at the docks into blocks for efficient handling; and the mixing of variable ores in the dock pockets to obtain uniformity throughout the cargo.

During this same period, the time available for grading and handling the ore from mine to vessel has been greatly reduced. Ore shipped from the Mesabi range in Minnesota is now transported to docks an average distance of 95 miles in five hours, in contrast to sixteen hours in 1920. Some of the larger power shovels in use in open-pit mines load as high as 1,000 tons per hour under normal conditions, so that ore moves from the mines rapidly.

Grades of ore offered are based on exploration data of the area to be mined, and closely approximate the average analysis of the property. The object is to supply the furnaces average analysis from cargo to cargo along with uniformity throughout each cargo. This must be done with ores of wide variation from average. Careful advance planning of the operation, and close cooperation between engineering, operating, and grading departments is essential to the delivery of the ore as required.

In a low-grade ore, analysis of samples taken from four or five cars, representing about 250 gross tons, will vary approximately as demonstrated by the figures in Table I.

No ore that is average ore comes from any one loading unit. It is therefore necessary to mix ore from several units to achieve the desired results.

Loaded cars are sampled promptly upon arrival in the mine yard. This is done by taking 24 quarter-pound scoopfuls of ore, in three rows of eight, lengthwise over the top of the car. The sampling points are determined by the use of a rubber-covered cable fitted with a weight on one end. Eight markers are attached to the cable, spaced 2 ft. apart beginning 2½ ft. from the weight. The sampler places the weight at one end of the car as near the center as he can determine it and stretches out the cable, allowing it to follow the "hills and valleys." He takes a scoopful of ore directly under each marker. If a chunk is encountered, he breaks off a piece one-half the size of his scoop. This operation is repeated with the two side lines which are placed two-thirds of the distance from the center to the side of the car. Four cars of 150,000 lb. or more capacity constitute a sample, or five cars of 100,000 lb. capacity. All cars represented in a sample are from the same loading unit. All samples are taken in weather-proof cans and promptly delivered to the laboratory, where, after prescribed crushing and mixing, each sample is analyzed for iron, phosphorus, silica, manganese, and alumina. A portion of each sample is held out to be combined with three others for the determination of moisture. All sampling that is done is closely supervised.

Table I—Analysis (Sample Dried at 212° F). Low-grade Iron Ores

	Percentages	
	Average	Extreme Variations
Iron	53.69	From 47.00 to 58.50
Phosphorus	0.070	From 0.046 to 0.103
Silica	9.22	From 5.00 to 12.90
Manganese	1.73	From 0.19 to 5.14
Alumina	4.79	From 1.95 to 14.00
Moisture	14.79	From 10.80 to 24.00

Table II—Average Analyses of Typical Ore Pockets of 250 or 300 Tons. Dry Basis

Percentages		
Iron	Silica	Alumina
53.83	8.51	4.81
53.75	8.79	4.94
52.86	9.26	5.08
52.63	9.47	6.20
54.48	8.78	4.29
52.45	9.58	6.52
54.49	9.76	4.18
54.65	10.08	3.77
54.09	10.04	4.27
53.85	9.52	4.57

Each sample is given a number which becomes the way-bill number when the cars are turned over to the transporting railroad. This number permanently identifies the four or five cars involved, in the laboratory as well as on the railroad, and makes it possible to handle and dispose of the cars as a unit without resorting to the use of individual car numbers.

If any loading unit is in a bank of ore of varying analysis, preliminary mixing is done by combing the bank with the dipper door open, allowing the ore to accumulate in front of the shovel. It is then picked up and dropped again before it is loaded into cars. Foreign material, lean ore, and rock are sorted out and disposed of on lean and waste piles. Otherwise, all mixing is done in the dock pockets.

When an ore train leaves the division point for the ore docks, the grading office is notified by telegraph, giving the content of the train by way-bill numbers. The grading office then telegraphs a switch order to the docks before the arrival of the train, assigning each way bill to a block. Blocks are numbered for identification and may be built up to cargo size, or several of them may be grouped to make a cargo.

Vessels which are to report for cargoes are immediately assigned to a block or combination of blocks. Sufficient tonnage is then graded in to make up the cargo. Blocks may be held in cars, or dumped into pockets, at the option of the dock superintendent, but whenever the ore is dumped, definite practice is followed to insure good mixture. Standard instructions usually are that not more than one car of any one sample shall be dumped in one pocket. Pockets hold about five cars each, so that five different samples would be represented under this method. In addition to this, the extremes of low- and high-grade ore are specially designated so that they will come together in the same pockets.

Table III—Analysis (Dry) by Hatches

Percentages					
Hatch No.	Iron	Phosphorus	Manganese	Silica	Alumina	Moisture
1	53.83	0.077	1.66	8.51	4.81	14.55
2	54.36	0.070	1.61	8.72	4.69	14.86
3	53.81	0.070	1.72	9.05	4.71	14.76
4	53.56	0.068	1.66	9.13	5.25	14.79
5	53.82	0.066	1.48	9.78	4.89	14.92
6	53.85	0.071	1.79	9.52	4.57	15.52
7	54.25	0.073	1.77	8.93	4.44	15.35
8	54.03	0.070	1.88	9.04	4.40	14.42
9	53.12	0.069	1.55	9.67	5.49	14.98
10	53.06	0.068	1.71	9.61	5.30	14.44
11	53.03	0.067	1.62	9.53	5.64	14.40
12	53.37	0.072	2.09	9.07	4.74	14.88
13	53.60	0.073	1.73	9.24	4.80	14.90
14	53.76	0.074	1.71	9.15	4.68	14.60
15	53.44	0.072	1.77	9.18	4.78	14.66
16	53.66	0.071	1.78	9.12	4.55	14.48
17	53.68	0.072	1.77	9.04	4.57	14.48
18	53.52	0.067	1.87	9.57	4.26	14.40
Average	53.69	0.070	1.73	9.22	4.79	14.79

Table IV—Analysis (Dry) by Compartments

Percentages						
Compartment No.	Iron	Phosphorus	Manganese	Silica	Alumina	Moisture
1	53.89	0.070	1.66	8.89	4.88	14.76
2	53.87	0.070	1.70	9.36	4.70	15.06
3	53.37	0.071	1.78	9.31	5.02	14.65
4	53.59	0.071	1.79	9.18	4.58	14.52
Average	53.69	0.070	1.73	9.22	4.79	14.79

The typical pocket averages given in Table II show the trend toward uniformity in contrast to the variations in Table I.

When the chutes are lowered, the ore miles as it runs into the cargo hold, and any subsequent handling mixes it again.

The number of pockets utilized is usually about double the number of hatches in the vessel, so that there is a further elimination of variations between hatches which tends to make the cargo uniform throughout, as demonstrated in the data presented in Table III, above.

Combining the hatches into compartments yields the comparison given in Table IV.

These methods are generally practiced throughout the industry with necessary changes to meet special conditions.

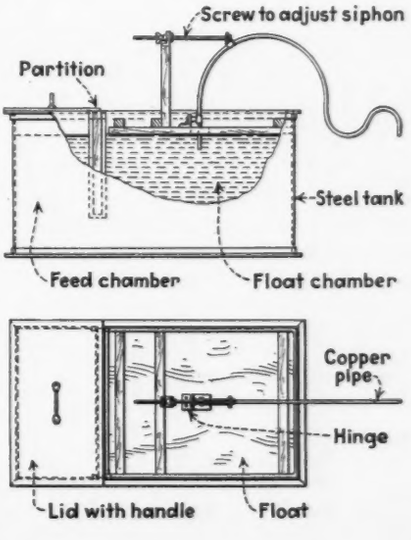
Underground properties accumulate stockpiles during the winter months which are mixed with the direct shaft product during the following season of navigation on the Great Lakes. Their product comes from numerous small working places in the mine and is mixed through frequent handling before shipment. This eliminates most of the wide variations apparent in open-pit car samples.

▼ ▼ ▼

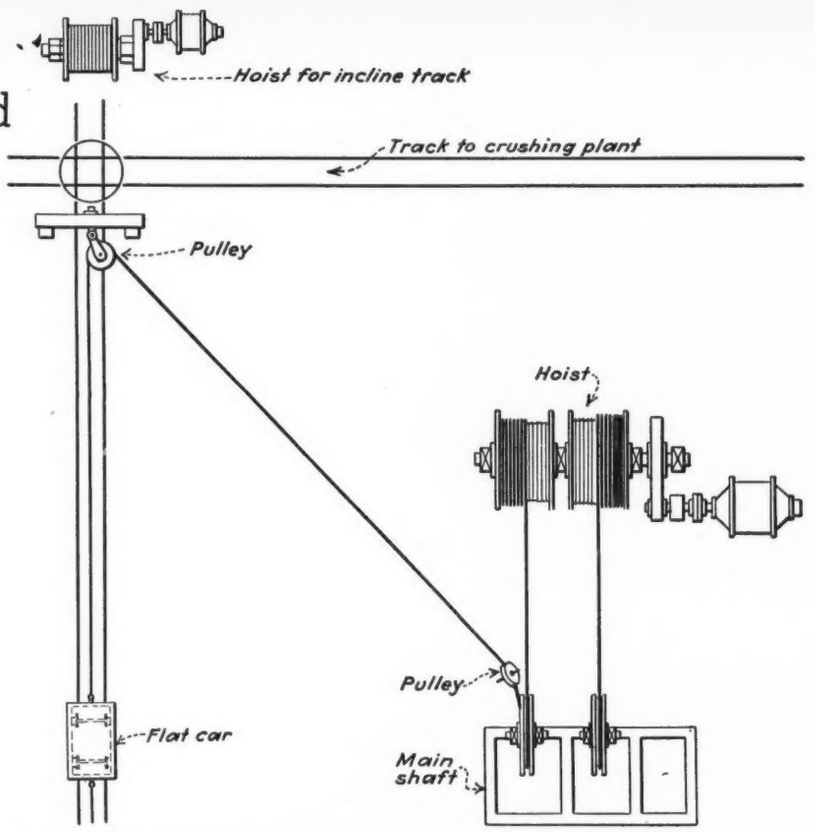
Novel Reagent Feeder

SIMPLICITY OF DESIGN and dependable performance are the outstanding features of the reagent feeder developed at the United Verde concentrator of Phelps Dodge Corporation, at Clarkdale, Ariz., by H. R. Herner, shift boss. Details of construction are given in the sketch.

As will be seen, it consists of a small steel tank divided by a removable partition into a feed chamber covered with a lid and a float chamber; the float proper made from wood; and a siphon of copper pipe. The siphon, secured to the top of the float by means of a hinge, can be raised or lowered by the simple screw mechanism on the wooden upright attached to the center brace of the float. Construction of the feeder is inexpensive. Scrap material can be used. Absence of moving parts assures continuous operation and low maintenance costs.



Incline Tram Worked By Main Hoist



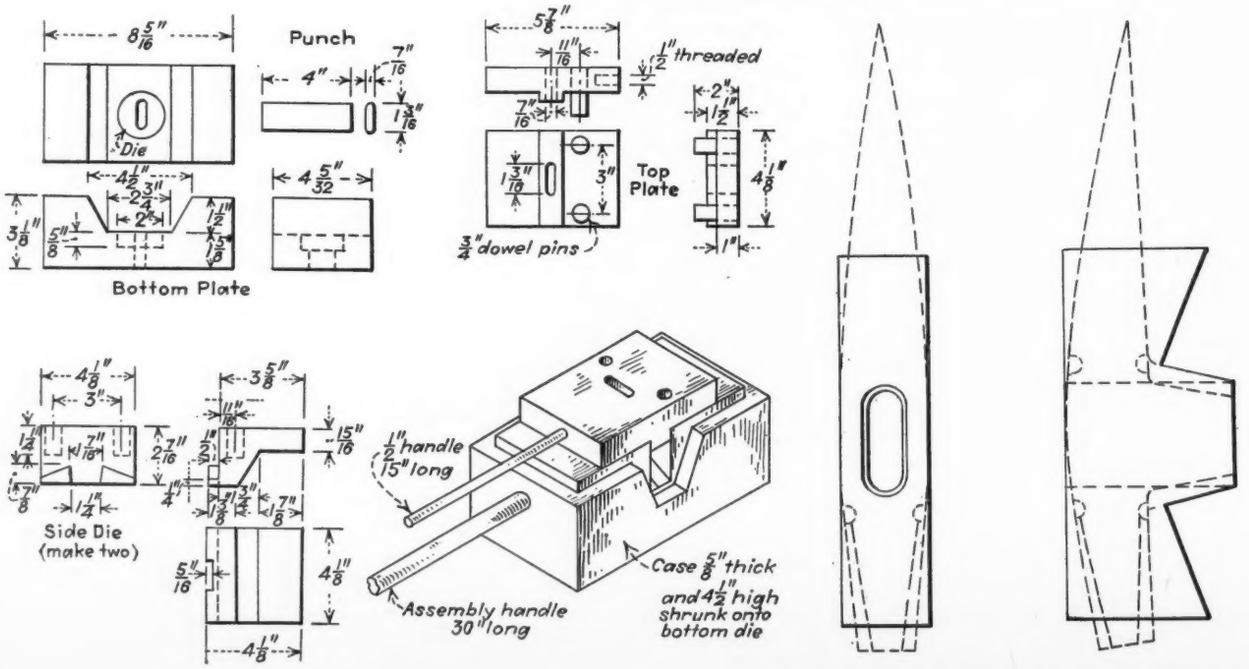
AT THE ZEIBRIGHT MINE, in Bear Valley, California, operated by Empire Star Mines Company, Ltd., machinery and materials needed at the crushing plant, mill, and hoisting plant are transported over an incline tram extending from the foot of the steep canyon wall to the main haulage level just above the building containing the primary crusher. Essentially, the haulage system consists of a main track running alongside the 500-ton mill, with feeder tracks at strategic points, and a four-wheel flat car operated by a single-drum hoist. Recently, transportation of materials was interrupted by failure of the hoist. The damage to the hoist was more serious than was at first realized, and a long shutdown seemed inevitable. With construction work in progress at the mill and certain materials being required daily for milling operations, suspension of the tram, even temporarily, was out of the question. As a consequence, some means had to be found to get the haulage system in working order in the shortest time possible. This was accomplished in the simple manner explained in the accompanying sketch.

The hoisting cable in the idle compartment of the main shaft was placed into the grooves of the pulleys or tackles installed temporarily at the foot of the headframe and a short distance below the damaged hoist and then secured to the coupling of the flat car. Temporary marks on the indicator dial enabled the hoistman to stop the car at any unloading point.

Forging Eyes of Small Hammers

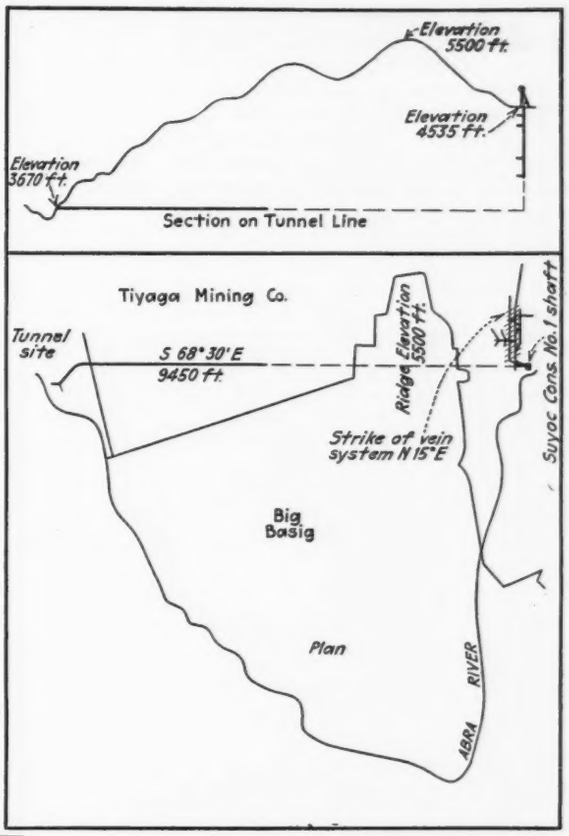
DETAILS of the set-up developed at the blacksmith shop of Anaconda Copper Mining Company, Butte, Mont., by J. H. Simmons, foreman, for forging the eye for sample picks, small hammers, and other handled tools are shown in the line cuts below. Previous to the adoption of this method, all such tools were hand forged and much care had to be exercised in making the eye in the center of the tool. Under the present scheme the stock is drop forged and then shaped into the desired form by hand.

The tool proper consists of several steel dies, which include a bottom plate with a replaceable cutting die and an assembly handle 30 in. long; top plate with dowel pins and hole for guiding eye punch; side die for shaping the exterior of the eye; and the steel punch. All pieces were made from scrap material at the machine shop. Punching and shaping of the stock are done under a steam hammer, and excess stock after being drawn to shape is cut off.



Fast Tunneling In the Philippines

Modern equipment and practice on Palidan-Suyoc project permit 1,327 ft. advance of 11x11 ft. heading in one month, operating with inexperienced labor



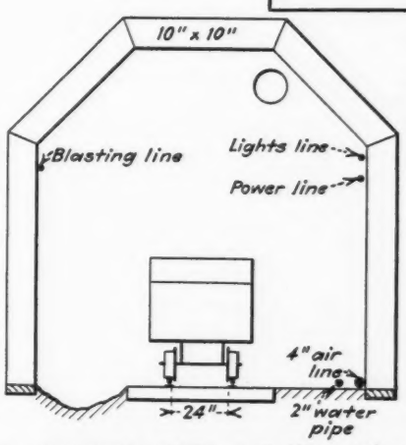
THE TUNNEL will cut Suyoc Consolidated No. 1 shaft at a point more than 800 ft. below the collar and in one place will have almost 2,000 ft. of backs. This sketch, in plan and section, shows the location

John W. Harman

Chief Engineer, Suyoc Consolidated Mining Company, Manila, P. I.

THE PALIDAN-SUYOC Deep Level Tunnel Company was organized for the purpose of driving a crosscut adit to prospect a large area of almost unprospected territory, covered by the claims of three distinct mining companies, and to cut the No. 1 shaft of the Suyoc Consolidated Mining Company at some distance below the collar. This will provide drainage of the Suyoc Consolidated workings and allow the development of a large area which could not previously be opened up because of danger of flooding the mine. The Tunnel company is a subsidiary of Marsman & Company, which operates Suyoc Consolidated under a management contract, and all of the preliminary work at the tunnel site was done by Suyoc engineers.

At the time of organization, Lloyd Pratt, who has had extensive tunnel experience on the Cascade tunnel, the Los Angeles aqueduct, the Hoover Dam diversion tunnels, and others, was asked to take the position of tunnel superintendent. He felt that good footage could be made and a saving effected by use of a drill carriage, a mechanical loader, and other equipment developed on modern tunnel jobs. He convinced J. D. Enberg, Northern Division manager, and it is to the assistance rendered by the latter that much of the credit for the work done is due. Credit must also be given to R. W. Crosby and L. M. Robinson. At this writing the tunnel is only about 35 per cent completed, but the work to date has proved that the new methods are definitely superior to older ones.



A SEGMENTED ARCH of 10x10-in. timber with 4x6-in. collar braces is used to support the ground where necessary

When completed, the tunnel will be about 9,450 ft. long, with a cross-section 11x11 ft. inside the timbers. It is driven on a grade of half of 1 per cent and will cut the Suyoc Consolidated No. 1 shaft at a little more than 800 ft. below the collar. The tunnel line almost exactly cuts the general strike of the Suyoc vein system at right angles and will, in one place, have backs of almost 3,000 feet.

In introducing modern tunneling methods into the Philippines, a question existed as to whether the average Filipino laborer could adapt himself to methods requiring close coordination of operations. Many felt that the work would be slowed up by the typical "one thought at a time" attitude of the Filipino. It speaks well for the organizing ability of Mr. Pratt and the patient teachings of the shift bosses, Maurice Walser, Herman Stokes, and Arnold Long, that these previously untrained Filipinos have been able to maintain a rate of advance which compares favorably with records made in American tunnels. A bulletin board erected near the office, which shows the performance of each shift and the footage made each day, has helped promote keen rivalry between crews, as has the policy of keeping one crew entirely made up of lowland Filipinos and another of Igorotes.

Drilling — The drill carriage, or "jumbo," used at Palidan was designed by Mr. Pratt, who attempted to remedy a number of mistakes made in the design of carriages previously used in the United States. The jumbo is made entirely of structural steel,

chiefly of U cross-section, and is held together by riveting and welding. Because of the small section of the tunnel, the carriage was made rather longer in proportion to its width than previous ones, to give sufficient weight. As may be seen in the photograph, the frame is simply an oblong skeleton, mounted on a pair of 24-in. gage trucks. Hinged near the top are the "wings" or platforms which are lowered when the jumbo is moved to and from the face. Each wing is made in two sections, to facilitate lowering and raising. On top of, and parallel to, the frame at the front are two extra-heavy 4-in. pipes, to which are welded the vertical columns. To each of these columns is attached, by universal clamps, the arms on which the top machines are mounted. The "lifter" machines are likewise mounted on arms attached to columns rigidly fastened to the frame.

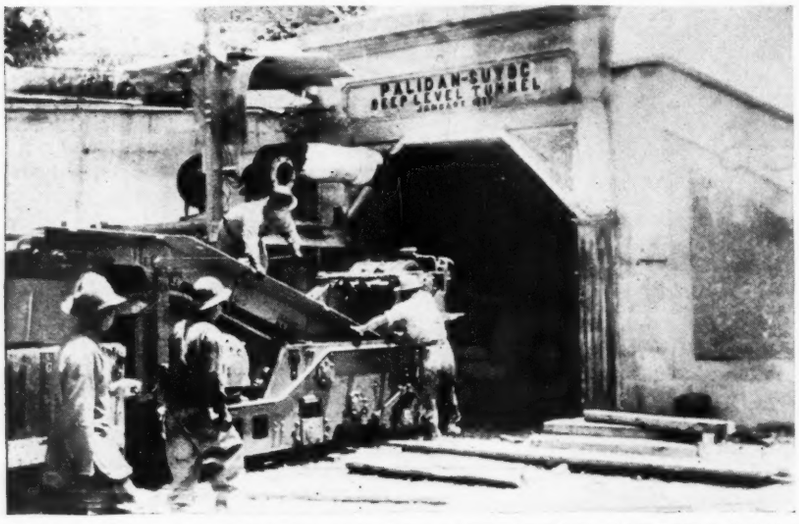
Air is supplied through a 4-in. manifold which runs from the right-hand rear of the frame, around the front, and back the other side to a blow-off valve. Line oilers are attached to all distributing lines. Water is supplied by a similar manifold.

Four 3½-in. Worthington pneumatic-feed drifters are mounted on the jumbo. These machines have been very satisfactory, requiring little attention and putting in more hole than anyone could ask.

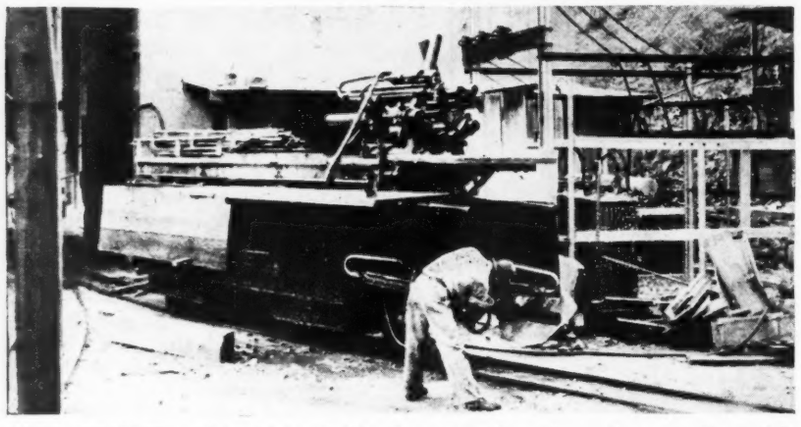
In use, the jumbo is pushed into the face by the locomotive and the air hose and water hose are connected. The line is always blown down to drain any condensed water before drilling is started. As soon as the lines are connected and blown out, the drills are started, they having been lined up while the hoses were being attached.

In the present ground about 30 holes are drilled These are blown and loaded, from the jumbo, with about ten sticks per hole of 1¼x8-in., 40 per cent dynamite. Electric caps are used entirely, eight delays being used.

A rather clever shooting switch has been devised which provides the maximum safety. This is an ordinary safety knife switch with a lock, to which only the native *capataz* has a key. The unusual part is a lead wire to the switch which must be stretched across the tunnel and plugged in to a socket on the opposite rib before the round can be fired. Alternating current at 440 volts is used for shot firing.



AT THE PORTAL of the Palidan-Suyoc tunnel, the ultimate length of which will be 9,450 ft. The mechanical mucking machine is just entering



DRILL CARRIAGE used in driving Palidan-Suyoc tunnel on the surface near the portal. On it are mounted four 3½-in. pneumatic-feed drifters

Steel Sharpening and Handling—Round, lugged drift steel 1¼ in. in diameter is used. The steel shop is provided with two Ingersoll-Rand Model 50 sharpeners, one Ingersoll-Rand R 26, and one Gardner-Denver Type 50 furnace. Dulled steel, as soon as removed from the machines, is stacked on a flat car behind the jumbo. This car is hauled to the steel shop as soon as the round is drilled out and the dull steel piled on the floor of the shop. The car is then immediately loaded with sharp steel from a rack just outside the shop. During the mucking cycle, the steel car is taken to the siding on which the jumbo rests and the steel transferred to a rack on the top deck of the jumbo. Steel gages and lengths are given in Table I, which will be found on page 56.

Mucking—A Type 50A short-boom Conway loader was ordered, but, due to various unfortunate delays, did not arrive at the tunnel site until May 20. Up to this time mucking had been entirely by hand. It might be well to add here that the tunnel was started entirely by hand, driving a top heading by hand drilling and then breaking the bench. When the jumbo was put into service in April the speed of driving was greatly increased, but no one can deny that a 100-ton muck pile is a most discouraging thing into which to sink a shovel. However, by hand mucking, a rate of about 250 ft. per month was maintained. Though the speed of advance recently can be attributed in part to better ground and to the natives' becoming more familiar with the routine, there is little doubt that the greater part of the credit must go to the Conway. In the period May 1 to 20 an advance of 161 ft. was made. In the ten remaining days of the month 379 ft. was made!

The improved California track switch is used for shifting cars. This is about 150 ft. long and is moved forward each day during the drilling cycle, using the Conway as a locomotive for pulling it. Enough has been written by others to make it unnecessary to go into any details or construction of the California switch in this paper.

In practice, a car is coupled to the Conway and filled in about 40 sec. The locomotive, with its train of cars, immediately hooks onto this car and pulls it into the siding. As soon as the switch is cleared an empty car is hand-trammed to the Conway and the cycle repeated. Only one locomotive is in use at present, though a 5-ton

Mancha storage-battery locomotive is due to arrive later. As soon as a train is made up, it is hauled to the tipple, and the cars are dumped and returned to the California switch. While the locomotive is taking out the train, cars are hand-trammed both to and from the Conway.

Cars used are 40-cu.ft., Granby-type automatic dump with $\frac{3}{8}$-in. sheet-iron sideboards added. These cars are most satisfactory, particularly in dumping, but are too small.

As soon as the loader has cleaned up to the limit of the rail, a 6-ft. section is immediately laid. These sections are a departure in tunnel driving and have been responsible for much saving in time. They differ from the usual section in that the 6-ft. lengths of 40-lb. rail are welded direct to $\frac{1}{2}$-in. iron plates. The space for these sections is cleared and ties are placed on grade. A cable is then looped around the section and the whole picked up by the digging teeth, on the bucket of the Conway, moved forward, and dropped into place. The rails are then bolted together, the cable is removed, and the mucking proceeds as before.

Haulage—A German diesel locomotive powered with a two-cylinder Mercedes Benz diesel is in use at present. This motor has not been entirely satisfactory, as it cannot run continuously without occasional breakdown. When the new storage-battery motor is put in service it will be possible to shut this diesel down occasionally and keep it serviced a little better. At present, shutting down the locomotive means a tie-up in tunnel driving because full-time haulage of rails, blower pipe, air pipe, and water pipe must be maintained in order that work in the heading may go ahead without interruption. Another disadvantage is that the diesel exhaust, contrary to the claims of the makers, fouls the air quite a bit. It does have the advantage of greater speed on the main line and will be used exclusively for main-line haulage after the battery locomotive arrives, the latter being used for switching cars in the headings.

Thirty-pound rail is used on the main track. When the heading has advanced enough for the rear end of the jumbo to be a rail length ahead of the first 6-ft. section of 40-lb. rail, the sections are removed and a length of rail is laid in their place. This work, as is most of the other auxiliary work, such as on pipes and surveying, is done during the drilling cycle.

An attempt is made to carry the track about 8 in. below the 0.5 per cent grade line so that it may be raised enough to put it out of the water if a heavy flow is cut.

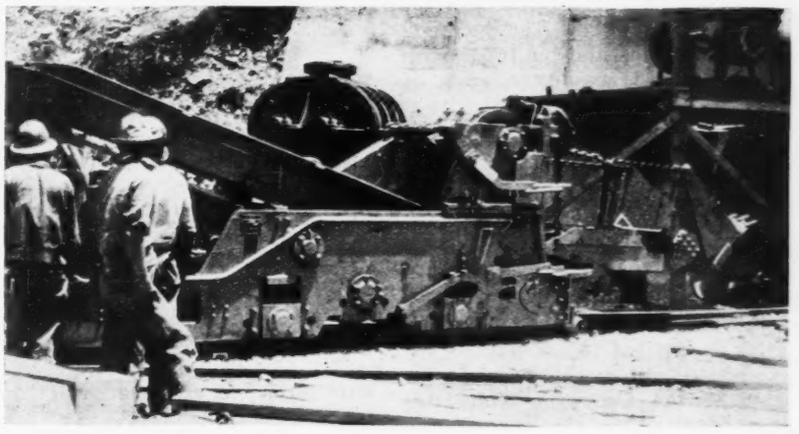
Compressed Air—Air for drilling and steel sharpening is furnished by a 1,000-c.f.m. Pennsylvania compressor driven by a 175-hp. Ideal synchronous motor. This machine is supplemented by a 500-c.f.m. Gardner-Denver "V" type compressor driven by a 100-hp. Caterpillar diesel through a short V-belt drive. It might be mentioned that the electrical unloader on the Pennsylvania machine has given much trouble and the machine has never delivered its rated capacity. Air is taken to the heading by a 4-in. pipe line, to which a length is added about twice daily.

Ventilation—The heading is ventilated by a 16-in., 4,500-c.f.m. Root positive-pressure blower which blows through 16-in. steel blower pipe. The motor to drive this blower was not installed until July 10, up to which time the only ventilation consisted of three 5-hp. centrifugal fans in parallel. The air forced through 2,000 ft. or more of 16-in. pipe by these fans were practically negligible, which makes the records made in speed of advance even more remarkable. I can attest that conditions were very unfavorable, having suffered some bad headaches from only about half an hour spent in the tunnel.

Power—Electric power is furnished by a 300-hp. Allen diesel engine and G.E. alternator installed by Palidan-Suyoc in the Suyoc Consolidated power house. This power is carried to the tunnel site at 4,000 volts. At the tunnel the line is split. A part is dropped by three Asea 100-kva. transformers to 440 volts for distribution to air compressor, pumps, and other outside motors. The 4,000-volt line is carried into the tunnel to a 3-phase, 75-kva., G.E. Pyranol portable transformer which steps the voltage down to 220 for the Conway. Power at 220 is carried to the Conway by about 1,200 ft. of G.E. tellurium-compounded cable. The transformer is moved about every 1,000 ft., the change requiring about 1½ hours.

A small, light transformer is carried in the tunnel to provide current for the lights, which are spaced every

IN THE HEADING a view of the front end of the loader, shown to better advantage below, is obtained. The introduction of this machine greatly speeded up the work



MECHANICAL LOADING MACHINE employed in mucking out the heading. It is a Type 50A short-boom Conway unit. It fills a 40-cu.ft. car in an average time of 40 sec.

50 ft. along the length of the tunnel.

Timbering—In ground which requires timber a segmented arch which consists of three segments and plumb posts is used. Sets are placed on 6-ft. centers. Posts and segments are 10x10 in. in dimensions and the collar braces 4x6 in.

As soon as the round is broken, crown bars are placed from the last set to hold the back while mucking. As soon as the face is cleaned up, foot blocks are placed on grade, being lined up from grade nails placed on the posts 3 ft. above grade. The posts are then erected with a spreader bar top and bottom and moved until on the center line. They are then blocked into place and the jumbo is brought to the face. The segments are then erected and blocked while the round is being drilled.

When the tunnel was started, it was necessary to spile through the first 80 ft. or more of loose ground. This part of the tunnel and a little more, 90 ft. in all, was later concreted. This was a laborious job, as the concrete had to be poured entirely by hand, no means of forcing it in under pressure being available. The last 1,500 ft. or more has not required timber, it being in a fairly solid gabbro with only a few minor slips. A few places have been well chewed up by more intensive faulting, requiring placing two or three sets of timber, but these have been rare.

Cycles of Operation—The operation is planned on the basis of two rounds each shift, and, except in cases of breakdown, there has been little deviation from this plan. After the round has been blasted, about 20 min. is allowed for the smoke to be cleared from the heading before the men enter the tunnel. As soon as the heading is reached, the Conway is moved to the face and a string of empty cars pushed onto the right side of the California switch. The locomotive is switched to the left side of the switch and an empty car is attached to the Conway. While this car is being loaded, the locomotive is pulled up close so it can hook onto the loaded car immediately. The first car being loaded, it is pulled by the locomotive onto the switch and an empty car hand trammed to the Conway. This switching is done very efficiently, but it is felt that proper equipment for switching would probably cut down the mucking time by 30 to 45 min. As soon as room is cleared for it, a new section of track is put down, the operation requiring perhaps five minutes. Time required for mucking averages about $1\frac{3}{4}$ hours.

If in ground that requires timber, the plumb posts are stood and blocked in place while the locomotive takes out the loaded cars and brings up the jumbo, which is kept on a second California switch about 1,000 ft. from the face. As soon as the posts are blocked in place, the jumbo is pushed into the face and the segments are put in place and blocked from it while the drills are running.

Practically all of the incidental work in the tunnel is done during the drilling cycle. This work includes the daily moving of the California switch, laying of track, hanging blower pipe, stringing light and blasting wires, the twice weekly extension of the survey line, and the occasional moving of the second California switch and the 220-volt transformer.

Drilling, as a rule, requires about $1\frac{1}{2}$ hours for an 8-ft. round. If the ground requires much timber, the round is drilled a little shorter to make up the time lost in timbering.

Table I—Drill Steel Gages and Lengths

	Feet	Inch Gage
Starter	4	$2\frac{1}{8}$
First change	6	2
Second change	8	$1\frac{7}{8}$
Third change	10	$1\frac{3}{4}$
Finish	12	$1\frac{5}{8}$

Table II—Cost of Operation

Places	June Dollars per foot	July Dollars per foot
Breaking	7.92	9.32
Mucking	0.84	0.87
Tramming	1.03	1.28
Ventilation	0.01	0.05
Engineering	0.10	0.08
General overhead	2.88	5.85
Total	14.74	17.73

Table III—Man-Shifts Per Foot, June and July, 1937

	June	July
Direct charges	2.00	1.88
Direct and indirect	2.62	2.37

There have been a few occasions in which three complete rounds have been made in a single shift. On one day, when the locomotive was under repair for 16 hours, the graveyard shift turned in an advance of 24 ft. for that shift alone.

Speed—Speed of advance has been far above expectations and it is felt that in view of the inadequate equipment, poor working conditions, and untrained labor, the world's record has been broken by a large margin. June was the first full month during which the Conway was in use, and a total advance of 1,088 ft. was made. It must be remembered that this was made with practically no ventilation. July showed the best progress. During this month about four days were lost in breakdowns, chiefly of the locomotive and the compressor. However, in spite of this lost time, an advance of 1,327 ft. was made. The best day so far has been July 31, on which date an advance of 58 ft. was made. The best work accounted for 341 ft. This all in rock tunnel, mostly without timber.

Safety—The 3,700 ft. of tunnel driven to date has resulted in no deaths, no haulage accidents, and only four minor lost-time accidents. When one considers that this record has been made with a class of labor which is not only unused to machinery but contemptuous of its potential danger and often ignorantly foolhardy, it is the more remarkable. Constant vigilance is observed by the shift bosses in an attempt to prevent accidents, although very few rules have been laid down.

Statistics—Costs in the driving of this tunnel have been almost fantastically low compared to costs in similar tunnels in the United States. The costs presented in the accompanying table are exclusive of depreciation but include all other items of operating expense, plus the generous footage bonuses paid to the men. Costs for June and July only are given, as these are the only months in which all equipment has been in full-time use.

A large part of the general overhead expense is that of keeping open for traffic a $7\frac{1}{2}$-km. road from the Suyoc Consolidated mill site to the tunnel site. This road clings to the sides of steep mountains. Almost every rain, and it rains every day, will bring down one or more slides. This keeps a crew of men and a tractor busy full time to maintain the road in condition so that supplies may be taken to the tunnel.

The records show that an average of 661 man-shifts were chargeable to outside work which is classified under general overhead during June and July. This does not include the steel-sharpening crew, compressor men, and others whose time is charged to the tunnel itself. In the tunnel, a total of 2,182 man-shifts was charged in June and 2,496 in July. This includes all tunnel workers, including track crew, electricians, motormen, machine men and chuck tenders.

An interesting comparison is made in Table III in reducing these figures to man-shifts per foot.

Conclusion—The Palidan-Suyoc deep level tunnel is the first, though probably not the last, drain tunnel to be driven in the Philippines using modern methods and equipment. In spite of the obstacles, not only natural but human, the tunnel has, to date, been driven at a much greater rate of speed and at much lower cost than Philippine mining men had thought possible. One may safely say that the eyes of the Philippine mining world have been opened by this job. It is my own personal opinion, that, in view of the unfavorable conditions, the 1,327 ft. made during July beats any previous world's record for tunnel driving.

NEW BOOKS

WOOD PRESERVATION. *By G. M. Hunt and G. A. Garratt. McGraw-Hill Book Company, New York. Pp. 457. Price $5.*

MUCH has been written on this subject, especially in the last twenty years, some of it controversial. Messrs. Hunt and Garratt, who are connected, respectively, with the United States Forest Products Laboratory and the Yale School of Forestry, summarize essential facts and principles. They deal with their subject under such headings as the field of wood preservation; agencies of wood deterioration; wood preservatives; preparation of material for treatment; wood-preserving processes; factors affecting penetration and absorption; economic aspects of preservative treatment; properties of treated wood; treating plants and equipment; and fire-retarding treatments. A large number of preservatives are considered, including oils (such as tars and creosotes) and chemicals, numerous proprietary preservatives, as well as paints and stains. Similarly, the number of preserving processes dealt with is large. Although only a few pages deal specifically with mine timber, the book will be useful in the mine office concerned with timber.

CANADIAN MINES HANDBOOK, 1938. *Northern Miner Press, Ltd., Toronto, Ont. Pp. 400. Price $1.*

LARGER than any previous edition, the new Handbook covers 5,319 companies. This number, according to the publisher, includes 560 new companies and 60 that were revised. The vast amount of information given about the operating companies and the list of those that are inactive or no longer existing makes the volume extremely valuable as a reference.

ENGINEERING METALLURGY. *By Bradley Stoughton and Allison Butts. Pp. 525. Illustrations 192. Tables 48. McGraw-Hill Book Company, New York and London. Price $4.*

THIS is the third edition of "a textbook for the users of metals" brought up to date by the authors, who are, respectively, dean of engineering and professor of metallurgy, and associate professor of metallurgy, at Lehigh University. The book has a broad scope, covering the production and refining of iron and steel and the principal non-ferrous metals, mechanical metallurgy, heat-treatment, welding, inspection and testing, properties and engineering uses, corrosion and its prevention. A new chapter has been added on the application of metals and alloys in engineering design, and numerous additions have been made to other chapters to reflect the latest developments. Technical data and statistical matter have been brought up to date.

TECHNICAL ANALYSIS OF ORES AND METALLURGICAL PRODUCTS. *By Franklin G. Hills, Chemical Publishing Company of N. Y. Inc., New York, Also E. & F. N. Spon, Ltd., London. Pp. 201. Price $3.*

THE AUTHOR, who is chemist of the State Experimental Plant at the Colorado School of Mines, at Golden, Colo., has prepared a compact, practical book, of value not only to the metallurgical chemist but to the engineer who at times is called on by circumstances to do or supervise inorganic analytical work. The range of treatment includes the principal elements, here numbering 29, also non-ferrous slags and cyanide mill solutions. A chapter is devoted to standard solutions and standardizing.

METAL-MINING COMPANY ACCOUNTING AND ADMINISTRATION. *By Frank Willcox. Pp. 128. Mercury Publishing Company, Montreal, Canada. Price: cloth $2; simulated leather, $2.25, half leather, $3.*

THE AUTHOR is a chartered accountant and associate member of the Canadian Institute of Mining and Metallurgy. That part of the book dealing with the organization and financing of mining companies relates particularly to Canadian Conditions, but the general discussion of accounting systems is pertinent to operations regardless of location. Separate consideration is given to prospects undergoing development and to producing mines. A chapter is devoted to depreciation, depletion, and taxation, and another to holding companies. Numerous forms are reproduced which should prove useful.

BIOGRAPHY OF BENJAMIN SMITH LYMAN. *By Gonpei Kuwada. Printed by the Sanseido Company, Ltd., Tokyo, 1937. Pp. 104, with 17 halftone illustrations.*

CREDITABLE alike to both author and publisher is this small volume of tribute to an affection for Benjamin Smith Lyman. "geologist, naturalist, philosopher, and benefactor of Japan," to quote the title of its opening page. Lyman was born in Northampton, Mass., in 1835. He attended Phillips-Exeter and was graduated from Harvard in 1855. From 1859 to 1861 he studied at the Ecole des Mines and at Freiburg. In his early professional career he was associated with J. Peter Lesley, a distinguished American geologist. Lyman did surveying work in Nova Scotia and Pennsylvania. He was assistant geologist of the State of Iowa. In 1870 he was engaged by the British Indian Government to survey the petroleum fields of the Punjab, and from 1873 to 1879 he was chief geologist and mining engineer for Japan. His work in that country involved not alone extensive and important investigations and surveys, but the teaching of geology to a large number of students, whose regard and esteem are chronicled in Mr. Kuwada's volume. The illustrations are interesting and the book is an excellent example of publishing and printing technique.

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PUBLICATIONS
RECEIVED

✦*The Philippine Mining Industry and the Government.* By Ralph Keeler, Box 769, Manila, P. I. Price $0.25. A series of seven articles on the present and future status of the mining industry under Philippine independence.

✦*George Westinghouse Commemoration.* A forum presenting the career and achievements of George Westinghouse on the 90th anniversary of his birth, conducted by American Society of Mechanical Engineers, Dec. 1, 1936. Published by the aforesaid Society, 29 West 39th St., New York. Pp. 78.

✦*Index to A.S.T.M. Standards and Tentative Standards.* Jan. 1, 1938. American Society for Testing Materials, 260 South Broad St., Philadelphia, Pa. Pp. 128.

✦*Annual Report of the Director of the Mint,* for fiscal year ended June 30, 1937. Includes report on production of precious metals in 1936. For sale by Superintendent of Documents, Washington, D. C. Price 60c.

✦*Bibliography of North American Geology,* 1935 and 1936. By Emma M. Thom. Bulletin 892, U. S. Geological Survey. Pp. 502. For sale by Superintendent of Documents, Washington, D. C. Price 50c.

✦*Geophysical Abstracts,* January-March, 1937. By W. Ayvazoglou. U. S. Geological Survey Bulletin 895A. Superintendent of Documents, Washington, D. C. Price 10c.

✦*A Statement of Accounting Principles.* By T. H. Sanders, H. R. Hatfield, and Underhill Moore. Published by American Institute of Accountants, 135 Cedar St., New York.

✦*Prevention of Silicosis on the Mines of the Witwatersrand.* A report on the investigations of the Miners' Phthisis Prevention Committee, Johannesburg, South Africa. Printed by the Government Printer, Pretoria. Pp. 286. Price 5s.

✦*Recherches Theoriques et Experimentales sur La Metallurgie Thermique du Zinc,* 1931—1938. By Octave Dony-Henault and Claude Deeroly. G. Thone, Liege, Belgium. Figures 63; pp. 269. Price, 75 Belgian francs, or $3.

Summary of the

MARKETS

THE TOTAL VOLUME of business booked in major non-ferrous metals during February was disappointing, the tonnage being smaller than in the first month of the year. Several moves in Washington, aimed at reversing the deflationary trend, had a mildly stimulating influence on sentiment late in the month. Fabricators of metals reported a moderate seasonal gain in business, lending some encouragement to the belief that trade during March will be better than in either of the first two months of the year.

Quotations averaged lower in February, the *E. & M. J.* index for the month falling to 73.43, against 75.56 in January and 91.68 in February last year.

Sales of copper in the domestic market totaled 23,518 tons for February, which contrasts with 25,543 tons in January and 26,504 tons in December. The domestic quotation held at 10c., Valley, throughout the month. The January statistics of the industry showed stocks of refined copper in the United States of 299,133 tons, against 259,351 tons a month previous. Production is being restricted in most directions, but the immediate hope for improvement in copper prices rests on substantial gains in actual consumption.

Business in copper in the foreign market held up well, sales fully balancing production. The export quotation moved above domestic copper on Feb. 22, 23, and 24, but the advance could not be sustained because of free offerings from America and a willingness on the part of some domestic producers to move a large tonnage at the 10c. level in the home market.

Demand for lead improved in the last two weeks of February, tending to steady the market on the 4½c. basis. Production and consumption are not far apart, a favorable factor.

Unfilled orders in zinc are being reduced and the market closed steady at 4¾c., St. Louis.

The Tin Committee cut production quotas from 70 per cent to 55 per cent of standard tonnages for the second quarter of 1938.

UNITED STATES MARKET

	Electrolytic Copper		Straits Tin	Lead		Zinc
1938 Feb.	Domestic (a)	Export (b)	New York	New York	St. Louis	St. Louis
1	9.775	9.525	40.875	4.90	4.75	5.00
2	9.775	9.600	41.000	4.90	4.75	5.00
3	9.775	9.500	40.600	4.90	4.75	5.00
4	9.775	9.400	40.600	4.90	4.75	5.00
5	9.775	9.400	40.750	4.90	4.75	5.00
7	9.775	9.425	40.625	4.90	4.75	4.75 @ 5.00
8	9.775	9.275	40.625	4.75	4.60	4.75
9	9.775	9.300	40.875	4.75	4.60	4.75
10	9.775	9.300	40.750	4.50	4.35	4.75
11	9.775	9.250	40.625	4.50	4.35	4.75
12	Holiday	9.275	Holiday	Holiday	Holiday	Holiday
14	9.775	9.225	40.625	4.50	4.35	4.75
15	9.775	9.250	41.125	4.50	4.35	4.75
16	9.775	9.375	41.500	4.50	4.35	4.75
17	9.775	9.525	41.750	4.50	4.35	4.75
18	9.775	9.675	42.000	4.50	4.35	4.75
19	9.775	9.775	42.500	4.50	4.35	4.75
21	9.775	9.700	41.875	4.50	4.35	4.75
22	Holiday	9.850	Holiday	Holiday	Holiday	Holiday
23	9.775	9.975	42.750	4.50	4.35	4.75
24	9.775	9.950	42.250	4.50	4.35	4.75
25	9.775	9.675	42.250	4.50	4.35	4.75
26	9.775	9.700	42.250	4.50	4.35	4.75
28	9.775	9.675	42.000	4.50	4.35	4.75
Average For month	9.775	9.525	41.373	4.632	4.482	4.813
AVERAGES FOR WEEK						
Feb.						
2	9.817	9.563	40.563	4.90	4.75	5.000
9	9.775	9.383	40.679	4.85	4.70	4.896
16	9.775	9.279	40.925	4.50	4.35	4.750
23	9.775	9.750	42.175	4.50	4.35	4.750
CALENDAR WEEK AVERAGES						
Feb.						
5	9.775	9.488	40.763	4.90	4.75	5.000
12	9.775	9.304	40.700	4.68	4.53	4.775
19	9.775	9.471	41.583	4.50	4.35	4.750
26	9.775	9.808	42.275	4.50	4.35	4.750

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.350c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

	Sterling Exchange		Silver		Gold	
1938 Feb.	"Checks"	"90-day demand"	(c) New York	London	London	(d) United States
1	5.01250	5.00500	44.750	20.1875	139s 7d	$35.00
2	5.00750	5.00000	44.750	20.1875	139s 9d	35.00
3	5.00750	5.00000	44.750	20.1250	139s 10d	35.00
4	5.01125	5.00375	44.750	20.2500	139s 9d	35.00
5	5.01000	5.00250	(e)	20.2500	139s 9d	35.00
7	5.00875	5.00125	44.750	20.3125	139s 9d	35.00
8	5.01000	5.00250	44.750	20.3750	139s 8d	35.00
9	5.01000	5.00250	44.750	20.3125	139s 8d	35.00
10	5.01125	5.00375	44.750	20.3125	139s 8d	35.00
11	5.02125	5.01375	44.750	20.2500	139s 9d	35.00
12	Holiday	Holiday	Holiday	20.1875	139s 9d	Holiday
14	5.02250	5.01500	44.750	20.1875	139s 9d	35.00
15	5.02625	5.01875	44.750	20.0625	139s 9d	35.00
16	5.03500	5.02875	44.750	20.0000	139s 9d	35.00
17	5.03250	5.02625	44.750	19.9375	139s 10d	35.00
18	5.03125	5.02375	44.750	19.9375	139s 10d	35.00
19	5.01750	5.01000	(e)	19.9375	139s 10d	35.00
21	5.01250	5.00500	44.750	20.0625	139s 10d	35.00
22	Holiday	Holiday	Holiday	20.1250	139s 9½d	Holiday
23	5.01875	5.01125	44.750	20.2500	139s 10½d	35.00
24	5.01375	5.00625	44.750	20.1250	139s 9½d	35.00
25	5.01875	5.01125	44.750	20.1875	139s 9½d	35.00
26	5.02125	5.01375	(e)	20.1875	139s 9½d	35.00
28	5.01875	5.01125	44.750	20.0625	139s 9½d	35.00
Average for Mo.	5.01722	.....	44.750	20.159	.....	35.00
AVERAGES FOR WEEK						
Feb						
2	5.00708	.....	44.750	.....	.....	.....
9	5.00958	.....	44.750	.....	.....	.....
16	5.02325	.....	44.750	.....	.....	.....
23	5.02250	.....	44.750	.....	.....	.....

Calendar week averages: New York Silver, Feb. 5th, 44.750; 12th, 44.750; 19th, 44.750; 26th, 44.750.

(c) Not quoted (Saturday).

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

(e) Silver other than newly mined domestic. Under Executive order effective Jan. 1, 1938, the U. S. Government's price on newly mined domestic silver was established at 64.64c. Handy & Harman's quotation for domestic silver, .999 fine, was 64⅛c. per ounce throughout February.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1938 Feb.	COPPER Standard Spot	COPPER Standard 3 months	COPPER Electro Bid	TIN Standard Spot	TIN Standard 3 months	LEAD Spot Buyers	LEAD Spot Sellers	LEAD 3 months Buyers	LEAD 3 months Sellers	ZINC Spot Buyers	ZINC Spot Sellers	ZINC 3 months Buyers	ZINC 3 months Sellers
1.....	39.6250	39.8125	43.7500	180.5000	180.7500	15.8125	15.9375	16.0000	16.0625	14.6250	14.6875	14.8125	14.8750
2.....	39.8125	40.0625	44.2500	182.0000	182.2500	15.7500	15.8125	15.9375	16.0000	14.7500	14.8750	14.9375	15.0625
3.....	39.2500	39.5000	43.7500	180.5000	180.6250	15.6250	15.6875	15.7500	15.8750	14.5625	14.6250	14.8125	14.8750
4.....	38.5000	38.7500	42.7500	179.2500	179.2500	15.5000	15.5625	15.6250	15.6875	14.3750	14.4375	14.5625	14.6250
7.....	38.5625	38.8125	42.7500	180.2500	180.2500	15.3125	15.3750	15.5625	15.6250	14.1250	14.2500	14.3750	14.4375
8.....	38.1875	38.3750	42.5000	178.7500	178.6250	14.9375	15.0000	15.1875	15.2500	14.0000	14.0625	14.1875	14.2500
9.....	39.0000	39.2500	43.2500	181.7500	181.5000	15.2500	15.3125	15.4375	15.5000	14.1250	14.1875	14.3750	14.4375
10.....	38.4375	38.6875	42.5000	180.2500	180.2500	14.9375	15.0000	15.1250	15.1875	13.7500	13.8125	14.0000	14.0625
11.....	38.1875	38.4375	42.0000	179.2500	179.2500	14.6875	14.7500	14.8750	14.9375	13.8125	13.8750	14.0625	14.1250
14.....	38.2500	38.5000	42.0000	180.2500	180.0000	14.7500	14.8750	14.9375	15.0625	13.6875	13.7500	13.9375	14.0000
15.....	38.4375	38.6875	42.0000	181.2500	181.2500	14.8750	15.0000	15.1250	15.1875	13.6250	13.6875	13.9375	14.0000
16.....	39.1875	39.4375	43.5000	184.2500	184.0000	15.0000	15.1250	15.1250	15.1875	13.8125	13.8750	14.0000	14.0625
17.....	39.8750	40.1250	43.5000	184.7500	184.2500	15.4375	15.5625	15.5000	15.5625	14.1875	14.2500	14.3750	14.4375
18.....	40.5000	40.6250	44.2500	185.0000	184.7500	15.5000	15.5625	15.6250	15.6875	14.5000	14.6250	14.7500	14.8125
21.....	40.1875	40.4375	44.0000	185.2500	185.0000	15.4375	15.5625	15.5625	15.6250	14.5625	14.6250	14.7500	14.8125
22.....	41.3750	41.5625	45.2500	186.7500	186.5000	15.8125	15.8750	15.8750	15.9375	14.8125	14.8750	15.0000	15.0625
23.....	42.1875	42.3125	45.5000	190.2500	190.0000	16.1250	16.1875	16.1875	16.2500	15.3750	15.4375	15.4375	15.5000
24.....	41.1875	41.3750	45.0000	189.2500	189.0000	15.7500	15.8125	15.7500	15.8125	15.1250	15.2500	15.1250	15.1875
25.....	40.4375	40.6250	44.2500	186.7500	186.2500	15.1875	15.3125	15.1875	15.2500	14.8750	14.9375	14.8750	14.9375
28.....	40.7500	41.0000	44.5000	186.6250	186.5000	15.5000	15.5625	15.4375	15.5000	14.6875	14.8125	14.8125	14.8750
Average for month...	39.597	.....	43.563	183.144	.....	15.402		15.525		14.408		14.589	

Prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton of 2,240 lb.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated
(March 1, 1938)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb ..... 20c.
Antimony, domestic, spot, lb ..... 13.750c.
Bismuth, ton lots, lb $1.00
Cadmium, lb ..... $1.00@$1.35
Calcium, lb., ton lots 98 @ 99 per cent ..... 75c.
Chromium, 97 per cent grade, lb ..... 85c.
Nickel, electrolytic cathodes, lb ..... 35c.
Magnesium, 99.8 per cent, carloads, lb ..... 30c.
Palladium, troy oz $24.00
Platinum, (Official quotation) troy oz $36.00
Quicksilver, flask of 76 lb., 100 flasks or more ..... $75@$76
Radium, mg. radium content $40.00
Selenium, 99.5 per cent, lb $2.00
Silicon, minimum 97 per cent, spot, lb ..... 16.50c.
Tellurium, lb ..... $1.75@$2.00
Thallium, 100 lb. or more, lb $6.50
Titanium, 96 to 98 per cent, lb $6.00
Zirconium, commercially pure, lb $7.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton ..... $30.00@$35.00
Chrome Ore, 48 @ 50 per cent, c.i.f. Atl. ports, long ton ..... $24.00@$26.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:
Old Range bessemer $5.25
Mesabi bessemer $5.10
Old Range non-bessemer $5.10
Mesabi, non-bessemer $4.95
Lead (Galena) 80 per cent, Joplin, Mo., ton $49.33
Manganese Ore, c.i.f. Atlantic ports, long ton unit:
52 @ 55 per cent ..... 45c.
50 @ 52 per cent ..... 45c.
44 @ 48 per cent ..... 40c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2 ..... 45c.
Tungsten Ore, per unit of WO_3:
Chinese duty paid ..... $23.00@$25.00
Domestic Scheelite ..... $20.00@$25.00
Vanadium Ore, per lb. of contained V_2O_5 ..... 27½c.
Zinc, Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton $30.00

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb 3c
Cobalt Oxide, 70 @ 71 per cent, lb ..... $1.67@$1.77
Copper Sulphate, 100 lb $4.25
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb $1.34
Sodium Sulphate, bulk, ton ..... $13.00@$15.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Bé, per lb. of contained Bé $23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb ..... 10½c.
Ferromanganese, 78 @ 82 per cent, gross ton $102.50
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo contained 95c
Ferrosilicon, 50 per cent, gross ton $69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained $1.95

NON-METALLIC MINERALS

Asbestos, f.o.b. mines ton:
Canadian (Quebec)
Crude No. 1 ..... $700@$750
Crude No. 2 ..... $150@$350
Spinning fibers ..... $110@$200
Paper stock ..... $40@$45
Shorts ..... $12@$16.50
Vermont
Shingle stock $57
Paper stock $40
Cement stock $25
Barytes, long ton:
Georgia, crude $7.00
Missouri, 90 per cent $BaSO_4$, less than 1 per cent iron ..... $6.00@$7.00
Bauxite, long ton:
Domestic, chemical, 55 @ 58 per cent ..... $6.50@$7.50
Domestic, abrasive, 70 @ 84 per cent ..... $12.50@$15.00
Dalmatian, 50 @ 55 per cent ..... (a)$6.50@$7.50
French, 56 @ 59 per cent ..... (a)$8.00@$9.00
China Clay, f.o.b. mines, ton:
South Carolina and Georgia, No. 1, bulk ..... $6.75@$8.00
Delaware, No. 1 ..... $14.50@.....
Feldspar, bulk, ton:
Potash feldspar, 200 mesh $17.00
Glass-spar, white, 20 mesh $11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton ..... $18@$19
Fuller's earth, f.o.b. Georgia or Florida, ton ..... $7.00@$14.00
Magnesite, per ton:
Dead-burned, f.o.b. California ..... $25.00@.....
Dead-burned, f.o.b. Washington ..... $25.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:
1½ x 2 in ..... 15@40c.
2 x 2 in ..... 30@60c.
3 x 3 in ..... 75@$1.20
3 x 4 in ..... $1.00@$1.40
4 x 6 in ..... $2.00@$2.50
White, ground, 70 mesh, ton ..... $60.00@$80.00
Ocher, Georgia, ton ..... $19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports ..... (a) 12@12½c.
Silica, water-floated, in bags, 325 mesh, ton ..... $16.00@$40.00
Sulphur, Texas mines, long ton ..... $18.00@.....
Talc, f.o.b. works, ton:
New York, double air-floated, 325 mesh ..... $12.00@$15.00
New Jersey, mineral pulp ..... $8.00@$10.00
Vermont, extra white, 200 mesh ..... $9.00@ $9.50
Tripoli, Missouri, ton:
40 mesh, cream colored ..... $15.00@.....
200 mesh, cream colored ..... $25.00@.....
(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:
Bessemer $24.50
Basic $23.50
No. 2 Foundry $24.00
Steel, base prices, Pittsburgh:
Billets, gross ton $37.00
Structural shapes, 100 lb $2.25
Bars, 100 lb $2.45

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1937	1938	1937	1938	1937	1938
January	44.913	44.750	20.734	19.895	490.670	499.895
February	44.750	44.750	20.083	20.159	489.307	501.722
March	45.130	.....	20.677	.....	488.412	.....
April	45.460	.....	20.740	.....	491.524	.....
May	45.025	.....	20.346	.....	493.835	.....
June	44.818	.....	20.022	.....	493.404	.....
July	44.750	.....	19.986	.....	496.582	.....
August	44.750	.....	19.848	.....	498.043	.....
September	44.750	.....	19.889	.....	495.145	.....
October	44.750	.....	19.942	.....	495.395	.....
November	44.750	.....	19.707	.....	499.467	.....
December	44.750	.....	18.835	.....	499.510	.....
Year	44.883	.....	20.067	.....	494.275	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		Electrolytic (a)	
	1937	1938	1937	1938	1937	1938	1937	1938
January	12.415	10.198	12.112	9.908	51.497	41.387	56.288	45.387
February	13.427	9.775	13.828	9.525	59.225	39.597	64.013	43.563
March	15.775	.....	16.590	.....	72.339	.....	76.167	.....
April	15.121	.....	14.692	.....	62.506	.....	66.614	.....
May	13.775	.....	13.999	.....	61.118	.....	63.684	.....
June	13.775	.....	13.492	.....	55.696	.....	61.409	.....
July	13.775	.....	13.817	.....	56.412	.....	62.807	.....
August	13.775	.....	13.926	.....	57.143	.....	63.595	.....
September	13.530	.....	12.984	.....	52.989	.....	58.966	.....
October	11.838	.....	11.207	.....	45.384	.....	50.619	.....
November	10.797	.....	9.850	.....	39.321	.....	44.023	.....
December	10.006	.....	9.714	.....	39.946	.....	43.886	.....
Year	13.167	.....	13.018	.....	54.465	.....	59.339	.....

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotation.

LEAD

	New York		St. Louis		London			
					Spot	3 Mos.	Spot	3 Mos.
	1937	1938	1937	1938	1937	1937	1938	1938
January	6.000	4.870	5.850	4.720	27.272	27.150	16.135	16.253
February	6.239	4.632	6.089	4.482	28.319	28.328	15.402	15.525
March	7.190	.....	7.040	.....	33.027	32.979	.....	.....
April	6.175	.....	6.025	.....	26.014	25.878	.....	.....
May	6.000	.....	5.850	.....	24.000	23.891	.....	.....
June	6.000	.....	5.850	.....	22.878	22.759	.....	.....
July	6.000	.....	5.850	.....	23.932	23.703	.....	.....
August	6.452	.....	6.302	.....	22.606	22.670	.....	.....
September	6.400	.....	6.250	.....	20.990	21.044	.....	.....
October	5.740	.....	5.590	.....	18.259	18.318	.....	.....
November	5.033	.....	4.883	.....	16.706	16.714	.....	.....
December	4.875	.....	4.725	.....	15.905	15.994	.....	.....
Year	6.009	.....	5.859	.....	23.326	23.286	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits, New York		Standard, Spot, London	
	1937	1938	1937	1938
January	50.925	41.548	229.350	183.619
February	52.010	41.373	233.750	183.144
March	63.043	.....	282.988	.....
April	59.172	.....	267.136	.....
May	55.651	.....	250.645	.....
June	55.851	.....	249.852	.....
July	59.245	.....	263.540	.....
August	59.465	.....	264.595	.....
September	58.675	.....	258.943	.....
October	51.654	.....	223.869	.....
November	43.299	.....	190.477	.....
December	43.051	.....	190.449	.....
Year	54.337	.....	242.133	.....

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
					Spot	3 Mos.
	1937	1938	1937	1937	1938	1938
January	5.847	5.000	21.153	21.281	14.994	15.173
February	6.465	4.813	25.122	25.322	14.408	14.589
March	7.381	.....	33.188	33.405	.....	.....
April	7.010	.....	26.216	26.344	.....	.....
May	6.750	.....	23.092	23.365	.....	.....
June	6.750	.....	21.409	21.528	.....	.....
July	6.923	.....	22.568	22.693	.....	.....
August	7.192	.....	24.140	24.290	.....	.....
September	7.190	.....	21.406	21.607	.....	.....
October	6.085	.....	17.722	17.955	.....	.....
November	5.630	.....	15.808	15.970	.....	.....
December	5.010	.....	15.274	15.429	.....	.....
Year	6.519	.....	22.258	22.432	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1937	1938	1937	1938
January	90.000	117.500	19.500	20.000
February	90.000	117.500	19.500	20.000
March	101.667	.....	20.000	.....
April	105.000	.....	20.000	.....
May	105.000	.....	20.000	.....
June	130.962	.....	20.000	.....
July	142.500	.....	20.000	.....
August	142.500	.....	20.000	.....
September	142.500	.....	20.000	.....
October	142.500	.....	20.000	.....
November	142.500	.....	20.000	.....
December	132.888	.....	20.000	.....
Year	122.335	.....	19.917	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1937	1938	1937	1938	1937	1938
January	14.130	13.750	90.250	79.240	50.400	36.000
February	14.563	13.750	91.000	76.455	64.364	36.000
March	16.375	.....	91.778	.....	58.000	.....
April	16.043	.....	92.000	.....	58.000	.....
May	14.830	.....	95.520	.....	54.800	.....
June	14.702	.....	96.654	.....	53.000	.....
July	14.803	.....	93.904	.....	50.115	.....
August	15.327	.....	91.423	.....	51.000	.....
September	16.555	.....	89.020	.....	51.000	.....
October	16.935	.....	86.140	.....	48.560	.....
November	15.848	.....	83.435	.....	43.652	.....
December	14.144	.....	81.038	.....	38.385	.....
Year	15.355	.....	90.180	.....	51.773	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1937	1938	1937	1938	1937	1938
January	21.50	24.50	20.50	23.50	21.00	24.00
February	21.50	24.50	20.50	23.50	21.00	24.00
March	24.20	.....	23.20	.....	23.70	.....
April	24.50	.....	23.50	.....	24.00	.....
May	24.50	.....	23.50	.....	24.00	.....
June	24.50	.....	23.50	.....	24.00	.....
July	24.50	.....	23.50	.....	24.00	.....
August	24.50	.....	23.50	.....	24.00	.....
September	24.50	.....	23.50	.....	24.00	.....
October	24.50	.....	23.50	.....	24.00	.....
November	24.50	.....	23.50	.....	24.00	.....
December	24.50	.....	23.50	.....	24.00	.....
Year	23.975	.....	22.975	.....	23.475	.....

Iron in dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

J. A. H. Paterson was recently made assistant general manager of The Mining Corporation of Canada.

Frederick F. Kett has assumed the post of general manager of the Mining Division of the Vanadium Corporation of America.

Prof. James Urquhart MacEwan, since 1936 associate professor of metallurgy at McGill University, has been appointed Berks professor of metallurgy at that institution.

Launcelot Owen, a British geologist, has been engaged by Papuan Apinaipi Petroleum, N. L., to carry out a survey in Papua.

C. E. Prior, managing director of Wiluna Gold Mines, Ltd., recently left Perth on a business visit to Great Britain.

A. St. Vincent, superintendent of Hull-Rust mine, at Hibbing, Minn., for Oliver Iron Mining Company, visited the mines of the Southwest recently.

A. D. Chisholm, Duluth, Minn., general manager for Pickands, Mather & Company, accompanied by Mrs. Chisholm, has sailed for a trip abroad.

Prof. E. W. Skeats, of the geology school, Melbourne University, returned at the end of December from a tour abroad.

Perry G. Harrison, Crosby, Minn., general manager of Evergreen Mining Company, accompanied by Mrs. Harrison, is on a Caribbean cruise.

Grover E. LeVeque, assistant general superintendent for the Inter State Iron Company, Virginia, Minn., is in Mexico.

John B. Knaebel, consulting mining engineer, returned recently to his San Francisco headquarters from a professional trip to San Salvador, C. A.

H. G. Hymer, formerly superintendent of Wabigon mine at Buhl, Minn., for M. A. Hanna & Company, is now associated with the General Chemical Company.

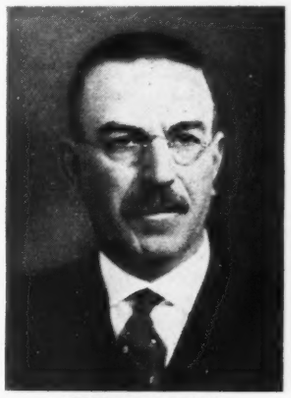
C. J. Rowe, formerly on the staff of the Anglo-Oriental Company in Malaya, is in charge of the sluicing operations of Oriomo Explorations, Ltd., at Hill End, N. S. W.

R. A. MacDonnell, formerly superintendent of the St. Paul mine for Republic Steel Corporation, has returned to Minnesota after a trip through Texas and Louisiana.

R. W. Whitney, manager, and **A. J. Stampe,** superintendent of the LaRue mine for Butler Brothers, have left for a trip to Alabama. It is reported that they will inspect an iron ore property that is now held under option.

Col. Percy E. Barbour sailed on March 4 on the S.S. "Santa Maria" for a two months' professional trip in South America.

Richard Faull, mechanical engineer of the ore mines and quarries division of the Tennessee Coal, Iron & Railroad Company, was, on Feb. 12, awarded a gold medal in recognition of 50 years of service with the United States Steel Corporation. Mr. Faull,



RICHARD FAULL

born in London, England, Dec. 9, 1868, joined the corporation May 17, 1887, as a machinist at the Soudan mine of the Minnesota Iron Company, which later was absorbed by the Oliver Iron Mining Company. His service is broken only by a nine-month period in 1894-95, due to slack operations of the Soudan mine.

Charles W. Burgess, resident Dorr Company engineer in the Philippines, sailed from Los Angeles on Feb. 5 for Manila, following a vacation of several months in the United States.

Merle H. Guise, placer engineer of Fairbanks, Alaska, is now on a prospecting cruise on the coast of British Colombia visiting the new gold camp at Zabellos before returning to Seattle, where he has headquarters at the Olympic Hotel.

Frank A. Wildes, retired State Chief Engineer, St. Paul, Minn., has received a life membership in the Engineers Club of Northern Minnesota in token of the esteem held for him by the engineers of the State.

Charles Chapman is in Tennessee, superintending the two flotation plants of the Phosphate Recovery Corporation at Wales and Mount Pleasant. He was formerly on the research staff of the same Corporation at Mulberry, Fla.

L. V. Waterhouse, director of Placer Development, Ltd., Bulolo Gold Dredging, Ltd., and associated companies, has been elected president of the Australasian Institute of Mining and Metallurgy for 1938.

Frank O. Jasmer is now associated with the Cia. Minera de San Jose de Gracia, S. A., at San Jose de Gracia, Sinaloa, Mexico, as mill superintendent and assayer. He was formerly mill foreman for Cia. Minera de Maguarichic, of Chihuahua, Mexico.

Prof. A. M. Gaudin, research professor of ore dressing at the Montana State School of Mines, Butte, Mont., spent several days in the Tri-State district last month as the guest of **George M. Fowler.** He was en route to the annual meeting of the American Institute of Mining and Metallurgical Engineers in New York.

Sherwin F. Kelly has been appointed a member of the finance committee of the American Geophysical Union, charged with certain duties in preparation for the 1939 meeting in Washington, D. C., of the Seventh Triennial Assembly of the International Union of Geodesy and Geophysics.

Virgil E. Frank recently accepted an appointment as an instructor in the School of Mines of the University of Minnesota. Previous to his appointment Mr. Frank was mining at Lark, Utah, for the United States Smelting, Refining & Mining Company and also working for the Anaconda company, at Butte, Mont., as a miner and shift boss.

H. C. Parmelee editor of *Engineering and Mining Journal,* visited last month the pitchblende-silver property of Eldorado Gold Mines, Ltd., Great Bear Lake, N. W. T., Canada. On his return trip he spent a day at the radium refinery, Port Hope, Ontario. An account of Eldorado's mining and milling operations will be published next month.

F. S. Elfred, Jr., president of the recently reorganized Evans-Wallower Zinc, Inc., will take a leave of absence from his duties with the Evans-Wallower Zinc, Inc., to become associated with the Western Cartridge Company of Alton, Ill. **Floyd W. Gooch,** of Joplin, general superintendent for the Evans-Wallower Zinc, Inc., will assume the duties of manager for the local operations of the company.

A. S. Richardson, chief ventilation engineer; **R. H. Sales,** chief geologist, and **J. D. Forrester,** of the Anaconda Copper Mining Company, and **Prof. A. M. Gaudin,** of the Montana School of Mines, were Montana representatives at the annual meeting of the American Institute of Mining and Metallurgical Engineers. Forrester, secretary of the local section of the Institute, acts as official delegate.

Sir William H. Bragg, an honorary member of the British Institute of Metals, was awarded on March 8 the medal of the Mond Nickel Company for outstanding services to non-ferrous metallurgy. The occasion marked the first presentation of the award, which was made in behalf of the council of the Institute by its president, **W. R. Barclay,** who has been succeeded by **Dr. C. H. Desch,** director of the department of metallurgy at the National Physical Laboratory, Teddington.

W. H. Williams, Inspector of Mines at Launceston, Tasmania, has been appointed Chief Inspector of Mines and of Explosives for Tasmania, in succession to **J. O. Hudson,** retired.

Senator Rodolfo Michels, President of the Committee of Mines of the Chilean Senate, has been elected a member of the board of directors of the Caja de Crédito Minero, Santiago, Chile.

C. E. Weed and Mrs. Weed arrived in Butte, Mont., Feb. 17. Mr. Weed, general superintendent of operations of the Anaconda Copper Mining Company, is directing his attentions to a study of Montana operations.

R. S. Russel, sales engineer of Broken Hill Associated Smelters, Pty. Ltd., has been awarded the Rennie memorial medal of the Australian Chemical Institute for his researches into the properties of lead.

Robert L. Hallett, of the National Lead Company, and **Louis D. Huntoon,** consulting engineer and geologist, have been elected by the Council of the Mining and Metallurgical Society of America to serve on the executive committee for the year 1938.

James F. McCarthy, president of the Hecla Mining Company, operating in the Coeur d'Alene region of Idaho, recently left on a vacation trip which will take him south to California, from there to Cuba, and later to New York.

Sanford R. Knapp, of New York, is in Montana on business pertaining to the operation of the Broadway mine, at Silver Star, in which he is interested with **A. V. Taylor** and **R. N. Nelson.** Taylor has just returned from a brief trip into the southwestern states.

George B. Lyman, who had been acting as mine superintendent at the plant of the United Verde branch of Phelps Dodge at Jerome, Ariz., has been appointed mine superintendent of the mines division at the Copper Queen Branch of the Corporation at Bisbee, Ariz.

Arthur Swanson, formerly manager of Cia. Minera Zacatecana, S. A., Pinos, Zacatecas, Mexico, has been appointed superintendent of the Zeibright mine at Emigrant Gap, Calif., operated by Empire Star Mines Company, Ltd. He succeeds **B. Berthelson,** who died recently in San Francisco.

Prof. C. K. Leith, of the University of Wisconsin, will speak on March 24 over the British Broadcasting Corporation in an international broadcast on "The Role of Minerals in the Present World Unrest." The address will go out from three London stations at 7:10 p.m. Eastern standard time. Professor Leith's talk is one of a weekly series on "The Way of Peace," arranged by the British Broadcasting Corporation.

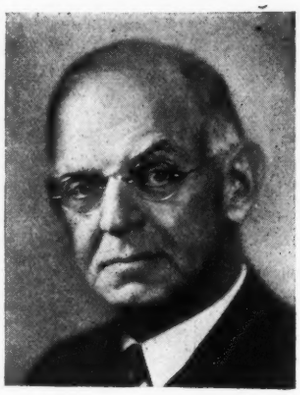
F. J. Laska, president of the Gold Standard Mines, Inc., operating the Katherine, Portland, Philadelphia, and Arabian mines in the Katherine district of Arizona, visited **Richard de Smet,** general manager, for several days in February. Mr. Laska had been on an inspection trip of mining properties in Lower California, Mexico, and went from here to his home in Chicago.

E. Hibbert has resigned as consulting engineer and director of Noranda Mines, Ltd., and has been succeeded by **Oliver Hall. R. V. Porritt** has been made assistant general manager. **J. R. Bradfield,** plant engineer at Noranda, has been appointed secretary of the company, **T. N, Hay,** former secretary, having resigned because of ill health. Mr. Bradfield will move to the head office of the company at Toronto. He is succeeded at Noranda by **W. M. Harvey. W. B. Boggs,** smelter superintendent, in addition to his duties will become consultant to the president of the company on the operations of Canadian Copper Refineries, Ltd.

Karl M. Stewart has resigned as general superintendent of Paracale Gold Mining Company to become assistant general manager of Nielson & Company, Inc., at 97 Cristobal St., Manila, P. I. Nielson & Company are operating properties in China, the Philippines, and the Malay States. He will continue to act as consulting engineer to Paracale Gold. **Mose E. Kelley,** of Tucson, Ariz., succeeds Mr. Stewart as general superintendent of Paracale Gold.

▼ ▼ ▼

OBITUARY



ALLEN HASTINGS ROGERS

Allen Hastings Rogers, senior partner in the consulting mining engineering firm of Rogers, Mayer & Ball, 26 Beaver St., New York City, died in New York on Feb. 14. He would have been 67 years old on Feb. 19. Mr. Rogers was born on Feb. 19, 1871, at Marshfield, Mass. After finishing in the Boston public schools, he attended Massachusetts Institute of Technology, from which institution he received his bachelor's degree in 1890. He began his mining engineering career with Phelps, Dodge & Company in Arizona in 1890 and three years later transferred his activities to the Boston & Montana Copper Company in Montana. Later he was successively associated with the Guggenheim Smelting Company in Mexico in 1894-95 and with the La Paz and Santa Fe Mining companies, in Mexico, as an engineer, in 1896-99. In 1900 Mr. Rogers became mine superintendent of the Guggenheim Exploration Company. He became, in 1903, general manager of the Velardena Mining & Smelting Company at Durango, Mexico. He came to New York in 1905 as the assistant general superintendent of the American Smelters Securities Company. He became a consulting mining engineer in 1906. Companies he aided in the period from that year until 1917 included the China Copper Company, Nevada Utah Company, L. Vogelstein & Company and the Canada Copper Company. In 1917 the firm of Rogers, Mayer & Ball was organized. Mr. Rogers belonged to the American Society of Mayflower Descendants and the Marshfield Historical Society, as well as to the A.I.M.E., technology and mining clubs, and the Marshfield Country Club. In 1917-19 he did war work as a "dollar a year" man with the Bureau of Mines in Washington. An appreciation of Mr. Rogers' services to engineering appeared in the issue of *Engineering and Mining Journal* of May 7, 1921.

Ernest Wilson, general manager of the Fraser & Chalmers engineering works of the General Electric Company (England), died on Feb. 18, at the age of 63.

W. H. Toole, for many years associated with deep lead mining at Ararat, Victoria, died on Dec. 15, 1937, aged 77 years.

William Fellowes, a pioneer mining man of Australia, for years associated with Frasers Gold mine at Southern Cross and long identified with mining on the Golden Mile, died on Dec. 29 last at Southern Cross at the age of 87.

George Borstand, naturalized American Swedish mining engineer who was widely known in western Mexico, was found dead recently, from poisoning, said to have been purposely taken, in his home in Guadalajara, Jalisco.

Prof. John A. Weir, for fourteen years a member of the faculty of the New Mexico School of Mines, died on Feb. 17 at Socorro, N. M. He was graduated from the Colorado School of Mines in 1909. From 1918 to 1921 he was superintendent at the Ozark Smelting & Refining Company plant at Magdalena, N. M. Professor Weir was affectionately known as "Pappy" by his students. He was a member of the New Mexico State Board of Regis-

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screwed

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Gerrit Jacobus Kapteyn, a prominent mining engineer and son of the famous astronomer J. C. Kapteyn, died in Davos, Switzerland, on Christmas day, 1937. Mr. Kapteyn, who was born in Groningen, Holland, secured his mining engineering degree at Freiberg in Germany in 1905 and planned to take further work at Stanford University. After reaching the United States, however, he immediately secured employment, working at mines in Cripple Creek, Ouray, Wyoming, Cobalt, Nicaragua, and California. In 1916 he stopped in Holland on his way to Russia for the Dorr Company and had to join the Dutch Army, then mobilizing. In 1924 he went to Sumatra, where he was chief engineer for the Redfang Labarg Gold Mine. In 1926 he became general manager of the Simau Gold Mine, which is also in Sumatra.

▼ ▼ ▼

Letters

Correcting Vertical Angles When Top Telescope Is Used

The Editor:

I HAVE READ with interest the article in your November issue on "Correcting Vertical Angles When Top Telescope Is Used," by Prof. S. Weeks and Charles D. Ramsden. It is not my desire to criticise the method described, beyond saying that to ascertain the vertical correction it would, in many places underground, be necessary to re-set up the instrument in a place straight for a distance great enough to admit of measuring along the floor the requisite length. This takes valuable time, of course.

For many years I have used, at home and abroad, an extremely simple and rapid method, which may prove helpful to some "budding" mine surveyor. It is as follows:

I always place the auxiliary telescope on the right side. I then set up under the plumb bob and adjust the two horizontal cross hairs of the telescopes, so that the telescopes give the same reading on a leveling rod. I then set the auxiliary telescope on the backsight and turn off the horizontal angle (which I simply note for my guidance) and also take the vertical angle to a short bit of string tied at a suitable point on the foresight plumb-bob string. Then I take hold of the O.G. end of the main telescope, to avoid disturbing the auxiliary's setting, and invert the instrument. This now brings the auxiliary to the left-hand side. I repeat both observations thus, and so get a doubling of the horizontal angle, which I divide by two to get the correct mean; and two single readings of the vertical angle.

In this way both vertical and horizontal angles were determined, once with the telescopes normal and once with them inverted. Thus every defect of the instrument is compensated for, and, save for the division of the doubled horizontal reading by two, no corrections whatsoever are needed.

To complete the work at the set-up I measure from the axis of the main telescope to the knot of string on the foresight plumb line; measure the height of instrument; also the height of the foresight knot, both above the floor there and the height to the spad from which it is suspended.

FRANK CLOKE

Interior Department Decisions On Mining Claims

The Editor:

OF LATE the Interior Department has been promulgating some decisions of such profound and radical departure from old well-established policy, appertaining to mining claims and their relations to homesteads, that it seems well to cite a few of the more extraordinary features, rulings that completely reverse scores of ruling decisions that have always governed in both the courts and the quasi-court of the Interior Department.

One of the most amazing of these new decisions, made on appeal by Assistant Secretary Oscar L. Chapman, is the *J. F. Woodbury et al.* case, promulgated Nov. 8, 1937, Case No. A-20818, which will perhaps appear for publication in the forthcoming Vol. 55 of I. D. (Int. Dept. Decisions). Assistant Secretary Chapman was elevated to his present adjudicating position only in 1933; before that he was office man for Senator Costigan, and before that prohibition officer at Denver.

High points in radical departure from older established rulings can best be briefly described as follows:

1. The devise of amendment falls obsolete in that mining claims automatically enlarge, to take in surface, without amendment, upon the abandonment of older stock-raising entries, unequivocally reversing the ruling case of *Filtrol Co.* v. *Brittan and Echart* (51 L.D. 649).

2. And automatically enlarges, without amendment, to take in overlap of prior mining claims subsisting at time of location—and clear-listed for patent. In effect reversing countless cases.

3. Assays and samples to prove discovery, made on the eve of contest, after inception of adverse litigation, govern, are accepted and prove discovery of mineral. Reverses *Ainsworth* v. *Beck* (53 I.D. 382); *Clark Montana Realty Co.*, v. *Ferguson* (218 Fed. 957); U. S., *Jones, Intervener* v. *N.P.R. Co.* (1 Fed. 2nd 53); and many more.

4. Held that a crumb of zinc ore, of a "massive" (sic) width of an even inch, found near the surface in a crack, was such as to warrant a prudent man to expect profitable ores at an admitted theoretical depth of 2,000 ft. where limestone is known to exist.

5. Building or marking monuments no longer essential. The claim passed to patent while admittedly no more than one monument was ever erected, and none ever marked. Just assumed or adopted old neighboring monuments of other claims.

6. A cabbage farm, passed to patent as mining claim; never used for mining other than rare desultory so-called assessment work. Used exclusively as agricultural land except as noted.

7. The decision stamps approval of title based in a location initiated by one who "jumped" an older claim covering the same ground, and who was a leaser, renter, caretaker, and who had been paid to do the assessment work on the older claim, but betrayed his fiduciary relations by "jumping" the older claim and using his assessment hole for his location work of the new claim, now clear-listed for patent. The decision clearly approves of such procedure.

8. Rules out "surprise" testimony, when put on by *defendant*, but approves such when by *plaintiff*; in all controversial matters and testimony, holds for plaintiff as against defendant; and numerous other novel features that should make the legal mind gasp with amazement.

And yet this case will govern until reversed in some later case!

Vanadium, N. M. ALFORD ROOS

Testing for Molybdenum

The Editor:

THE QUALITATIVE test for molybdenum described by R. H. Lowe in *Engineering and Mining Journal* for November is unnecessarily complicated for ordinary mineral identification. Usually all that is desired is to distinguish molybdenite from graphite, or wulfenite from some other mineral. This can be accomplished by boiling a few milligrams of the mineral in about 1 cc. of dilute (1:1) nitric acid in a test tube (a centrifuge tube is more convenient than an ordinary test tube) for a few minutes, diluting to 10 or 12 cc. and adding a pinch of xanthate. Molybdenum, if present, will give the pink to purple precipitate described by Mr. Lowe. The only element likely to interfere is iron, which gives a brownish-red precipitate. If this comes down, the test should be repeated, the iron precipitated with ammonia, filtered out, and the filtrated tested with xanthate after slight acidification. If the solution is too strongly acid it will decompose the xanthate before the molybdenum reaction can take place.

I have used the procedure described in the foregoing for the past eight or ten years and find it perfectly satisfactory.

HORACE F. LUNT

Denver, Colo.

What Metal Statistics Show

DOMESTIC BASE-METAL producers have received no substantial encouragement in the general business improvement so far this quarter, and production schedules of some mines have started to shrink to lower levels. Base metal statistics for January proved discouraging. During the latter part of February, however, sentiment improved slightly, both here and abroad, following the political developments in Europe. This excitement, however, waned quickly, but producers view the future with hopes of a seasonal upturn in business soon that may be reflected in the mining districts later in the year. Lead and zinc producers are concerned with the proposed reciprocal trade agreements with the United Kingdom and Canada, that may reduce existing tariffs on lead and zinc ores and some of their products. Statistics on world production of lead and zinc indicate that our domestic lead and zinc mining industries can produce sufficient metal for our domestic requirements and producers hold traiff reductions would be ruinous for many.

Domestic copper statistics for January were disappointing, as production of blister was about 60,000 tons, compared to actual consumption now estimated by the trade to be around 30,000 tons per month. Copper statistics for February soon to be released are expected to show another large increase in domestic stocks.

The statistics of the copper industry, covering December and January, are summarized as follows, in short tons:

	Dec.	Jan.
Production (blister):		
U. S. mine	53,026	49,647
U. S. scrap, etc.	8,730	9,160
Foreign mine	91,896	97,027
Foreign scrap, etc.	12,955	12,728
Totals	166,607	168,562
Production refined:		
United States	60,463	70,487
Foreign	119,409	103,815
Totals	179,872	174,302
Deliveries to customers:		
Domestic	18,660	24,881
Foreign	103,863	114,647
Totals	122,523	139,528
U. S. exports of domestic copper	4,128	5,824
Stocks, refined:		
United States	259,351	299,133
Foreign	211,844	206,836
Totals	471,195	505,969

► LEAD—Production of refined lead was reduced sharply in January and with shipments to consumers slightly higher, stocks increased only 4,270 tons. Consumers have been buying more lead lately, and some in the industry believe shipments will be good in February. Consumers making products used in the building trades are reported to be more active, buying metal to cover business believed to have been encouraged by the Federal Housing Administration. Large consuming interests such as battery, cable and pigment makers have so far bought in a modest way.

The refined-lead statistics for December and January, in short tons, according to the American Bureau of Metal Statistics, are summarized as follows:

	Dec.	Jan.
Stock at beginning	113,573	129,131
Production:		
Domestic ore	47,423	37,651
Secondary and foreign	2,158	1,545
Totals	49,581	39,196
Domestic shipments	34,020	34,923
Stock at end	129,131	133,401

World production of refined lead in January totaled 159,041 short tons, according to the American Bureau of Metal Statistics. This compares with 165,566 tons in December, a decrease of 6,525 tons.

	Dec.	Jan.
United States (a)	47,423	37,651
Canada	17,760	17,779
Mexico	20,761	21,037
Austria and Yugoslavia	1,628	(e)1,500
France	4,465	3,338
Germany	16,519	(e)16,500
Italy	3,527	4,189
Poland	818	992
Other Europe (b)	16,300	15,800
Australia (c)	19,826	21,074
Burma	7,252	7,476
Tunis	1,787	2,205
Elsewhere (d)	7,500	9,500
World's totals	165,566	159,041
United States	47,423	37,651
Elsewhere	118,143	121,390

(a) Domestic only. (b) Belgium, Russia, Great Britain, and Czechoslovakia; partly estimated. (c) Includes Australian lead refined in Great Britain. (d) Argentina, Peru, Japan, and the product of foreign ore smelted in U. S.; partly estimated; also inclusive of what is probably the major part of the production in Spain. (e) Estimated or partly estimated.

► ZINC—A seasonal improvement is beginning to be felt by galvanizers, and zinc producers have seen a better inquiry for metal. Stocks of zinc, however, continue to climb, and production schedules in the Western and Central States remain on a curtailed basis.

The statistics of the American Zinc Institute for January and February, covering all grades, are summarized as follows, in short tons:

	Jan.	Feb.
Production	48,687	41,146
Prod., daily rate	1,517	1,470
Shipments	24,931	21,540
Stock at end	88,532	108,138
Unfilled orders	45,400	38,891

The Prime Western division of the zinc industry reports as follows for January and February on the common grades:

	Jan.	Feb.
Stock at beginning	29,334	40,699
Production	24,865	21,755
Shipments	13,500	14,223
Stock at end	40,699	48,231

Copper Production Outside United States

(American Bureau of Metal Statistics)

An accounting of the production of copper in the world from ore originating outside of the United States, according to countries where produced as blister copper (with a few exceptions hereinafter noted) during 1936 and 1937, is given below, a few of the figures for 1937, especially that for Russia, being estimated.

	Year 1936	First Quarter 1937	Second Quarter 1937	Third Quarter 1937	Fourth Quarter 1937	Year 1937
U. S. (foreign ore) (a)	44,100	12,900	17,600	19,600	19,400	69,500
Mexico (b)	35,400	13,900	13,600	13,600	9,700	50,800
Canada	189,200	53,200	54,900	56,400	62,500	227,000
Chile	269,600	115,200	125,700	97,400	98,700	437,000
Peru	35,700	9,400	9,000	9,600	9,600	37,600
Germany	65,500	17,600	17,600	18,200	18,200	71,600
Russia	91,500	24,000	26,000	26,000	26,000	(f)102,000
Other Europe (c)	91,800	22,500	20,800	23,500	25,000	91,800
Japan (d)	86,600	22,300	24,000	24,600	25,100	96,000
India	8,000	2,100	1,800	2,000	2,000	7,900
Other Asia	1,200	300	300	300	300	1,200
Australia	17,800	4,500	4,800	5,300	4,700	19,300
Africa (e)	269,600	98,600	115,000	98,700	97,800	410,100
Totals	1,206,000	396,500	431,100	395,200	399,000	1,621,800
Monthly average	100,500	132,167	143,700	131,733	133,000	135,150
Daily average	3,295	4,406	4,737	4,296	4,337	4,443

(a) Copper content of ore and matte imported, including receipts from Cuba, the latter admitted duty free. (b) Imports of blister copper into the United States from Mexico, except that the total for 1936 is the reported production. (c) Partly estimated; includes Finland, Great Britain, Spain, France, Norway, Sweden, Italy, Rumania, Yugoslavia, and Belgium ex Katanga; copper from Katanga matte smelted in Belgium is credited to Africa. (d) Japanese production is given in terms of refined copper. (e) Comprises Belgian Congo, Rhodesia and Union of South Africa. (f) Conjectural.

Cactus Mines Company, near Mojave, Calif., recently installed additional equipment to increase mill capacity to 125 tons daily. Flotation and cyanide processes are used and a small refinery was recently completed

CALIFORNIA

Hall of Mineral Empire Dedicated on Treasure Island

Mining men attend ceremony at site of 1939 Golden Gate International Exposition —Anglo American Mining Corporation buys Oceanic quicksilver mine

▶ On Feb. 13 several hundred mining men and guests from the Bay area and Mother Lode country gathered on Treasure Island, in San Francisco Bay, the site for the Golden Gate International Exposition to be held in 1939, to witness the dedication of the Hall of Mineral Empire, a million dollar project sponsored by Mining Exhibits, Inc., headed by B. C. Austin, well-known mining engineer. Following a brief address of welcome by President Austin, State Senator Jerrold Seawell, master of ceremonies, introduced the speakers scheduled on the program. Short addresses were made by Mayor Angelo Rossi of San Francisco; General W. E. Gilmore, who spoke for Leland Cutler, president of the Exposition, absent because of illness; the Hon. Thomas E. Campbell, ex-Governor of Arizona and executive vice-president of Mining Exhibits, Inc., and others. Adverse weather conditions prevented the actual laying of the corner stone, which is a boulder of gold-bearing rock brought from Coloma, where James Marshall discovered gold.

▶ Cactus Mines, Inc., Roy W. Moore, manager, has increased the capacity of its 100-ton mill near Mojave by the addition of new equipment that includes a 35 x 10-ft. Dorr primary thickener and a 35 x 27-ft. Dorr four-compartment washing thickener, with construction work being performed under contract by the Southwestern Engineering Company, of Los Angeles. The plant uses both flotation and cyanide processes.

▶ The Mining Association of California, 381 Bush St., San Francisco, through its general manager, Claude M. Chaplin, has advised Insurance Commissioner Samuel L. Carpenter, Jr., that an attempt is being made to prevent the local mining industry from securing a $250,000 reduction in mining compensation insurances rates in 1938 due under the rating experience of 1936. In his letter, Mr. Chaplin points out that actual experience with accidents in the California mining industry during the year 1936 warrants immediate reduction in mine compensation insurance rates from the present underground rate of $9.44 per $100 payroll to $7 or less per $100 payroll, and in surface mining from $7.72 to about $5 per $100 payroll. In addition, Mr. Chaplin asserts that certain elements in the compensation insurance business in California are attempting to prevent application of these low rates in 1938 policies by substituting the rating experience of 1937 for that of 1936, which is said to be lower. Mining men are watching with keen interest the outcome of this controversy.

▶ Satisfactory progress is being made on the construction of the gold placer dredge started recently by Gold Hill Dredging Company at the Kister property east of Gridley, Butte County, and production is scheduled to commence about March 15. The unit under construction operated until a short time ago in the Folsom area, and is designed to dig 60 ft. below water. The steel hull measures 112 x 52 x 8 ft., and 9-cu.ft. buckets are used on the digging ladder. H. L. Coney, superintendent, is in charge of construction.

▶ Purchase of the Oceanic quicksilver mine, at Cambria, owned by Anglo-American Mining Corporation, San Francisco, and the Greenhorn mine, near Redding, a gold-copper property, is outlined in a registration statement filed by Consolidated Sierra Mining & Milling Corporation with SEC, covering $800,000 of 5 per cent convertible debentures due 1947, 320,000 shares of common stock, and 160,000 stock purchase warrants. A part of the proceeds is to be used for purchase of mining and milling equipment, payment of RFC notes, and for working capital. The company, headed by William N. Albee, of Detroit, Mich., holds an option on the Oceanic mine and a purchase contract on the Greenhorn mine, where a 300-ton mill is to be erected soon for the beneficiation of a large tonnage of gold-bearing gossan and gold-copper ores.

▶ Open-cut mining operations are now being carried on with a ½-yd. power shovel at the property of Gold Company, Ltd., G. G. Chisholm, president, at Garden Valley, where a large surface vein is available for exploitation. The material removed by contract is treated in a 120-ton flotation plant equipped with a ball mill and classifier, a hydraulic jig, and flotation machines.

▶ Anglo American Mining Corporation, Ltd., H. W. Klipstein, executive vice-president, San Francisco, has completed the new plant capable of crushing 2,000 tons of ore a day and milling and treating about 500 tons of resultant screen material at the Yellow Aster mine, Randsburg. Operations are directed by A. W. Frolli, general manager. Walter Y. Brown is president of the corporation.

▶ The mill at the Lady Bug property, near Washington, Nevada County, is being enlarged to ten stamps, with ten additional stamps to be added early in spring. The mine was recently acquired by a New York syndicate, represented by R. P. Sharpe, Nevada City, and both extensive underground development and plant improvements are planned for the near future.

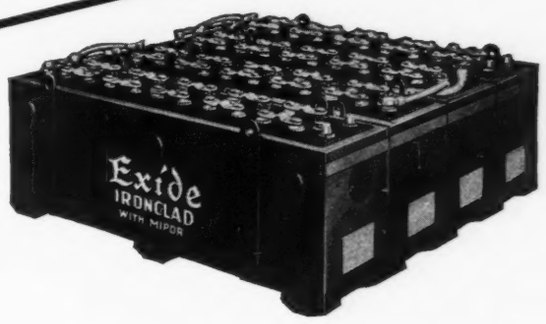
▶ Normal operating conditions were restored at the Argonaut mine, at Jackson, Amador County, after a brief shutdown caused by an unexplained underground fire. The blaze is said to have been discovered in an abandoned crosscut in the 4,300 level area, and was brought under control rapidly by use of water and bulkheading. At the neighboring Kennedy mine, which is connected with the Argonaut on the 5,700 level, underground work also was stopped temporarily as a precautionary measure. Alex F. Ross is superintendent at the Argonaut mine.

▶ In addition to further development of orebodies at depth, a 40-ton milling plant is scheduled to be installed at the Ontop mine, near Quincy, Plumas County. The property is controlled by H. E. Fowler and D. H. Mitchell, both of Quincy, and E. I. Lane, of Portola, Calif.

▶ Early erection of a 100-ton mill is reported to be planned by the Cord interests, of Beverly Hills, on the Keane Wonder mine, in Inyo County, near Death Valley, acquired recently from Coen Companies, Inc., of Los Angeles. Work in progress at the mine includes rehabilitation of surface buildings, installation of equipment, and underground development.

Correction — The Washington and Milkmaid mines, in Shasta County, Calif., are operated by J. H. Scott, and not by Newmont interests, as reported on page 90 of the February issue.

"Cut underground haulage costs? That's easy . . . install Exide-Ironclad Batteries"



IT is often easier to make claims for lower costs than it is to back them up. But in the case of Exide-Ironclad Batteries, their record speaks for itself. They are the most widely used batteries in underground haulage service today.

This in itself is significant. And the reports of users agree on the advantages these batteries offer. Five and more years of service without a cent of repairs is a common experience.

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NEVADA

Cold Halts Milling in Various Districts

Heavy snows close many roads—Gray Rock Mining Company sinking Elkoro mine shaft—Rip Van Winkle to diamond drill

▶ Heavy snows in the Comstock area around mid-February closed connecting roads and interrupted nearly all milling for several days, notably where the ore supply is drawn from surface cuts. The interruption caused no appreciable loss and there was no failure of power. At the Arizona Comstock Corporation mill, W. J. Loring, president and manager, made some needed adjustments in flotation units, and the plant is treating around 400 tons per day.

▶ Carload shipments of gold ore are being made with regularity to Utah smelters by the Nevada Rand Mining Company, organized in December to acquire the old Rand mine, in the Bovard district, Mineral County. Harry and B. A. Asner, brothers, head the company.

▶ Acting for the Champion Mining Company, which is developing a gold property in the Gillis range in Mineral County, L. E. Stein, president, has secured a long-term lease and option on the Vanderbilt mine, at Silver Peak, Esmeralda County. The Champion company is preparing for work on a substantial scale and will grant leases in old sections of the tunnel workings where rich ore remains in many large pillars.

▶ A contract will be let by the Rip Van Winkle Mining Company for extensive diamond drilling to seek the extension at depth of large bodies of lead-zinc-silver ore opened in its old mine in the Lone Mountain or Merrimac district in Elko County. Edwin Seymour is in charge, with an office at Elko.

▶ A brief report to stockholders on 1937 activities of the Goldfield Consolidated Mines Company states that in 1937 the Eastern Exploration Company, subsidiary of Calumet & Hecla Consolidated Copper, operating the Goldfield properties, in Nevada, under option of purchase, produced 4,933 tons of ore with gross value of $337,332, of which $88,276 was retained as royalty. Goldfield Consolidated during the year acquired 25,000 shares (25 per cent) of Livengood Placers, Inc., with extensive properties 60 miles north of Fairbanks, Alaska. On Jan. 30, 1938, the Callahan Zinc-Lead Company advanced $250,000 to Livengood Placers for additional property payments. At the close of this transaction, Goldfield retains 19,000 shares of Livengood Placers and has acquired 101,945 shares of Callahan Zinc-Lead. The developed and probable reserve between drill lines is approximately 33,000,000 cu.yd. averaging 50c per cubic yard. The first 12,000,000 cu.yd. to be dredged has been thoroughly prospected, showing a value of 64c per cubic yard. Of 170 properties presented during the year, the exploration department examined 57, and out of these, seven were developed to some extent. The year's operations resulted in net loss of $21,351.92, but considerably more than this was expended on properties upon which options were not exercised.

▶ The Gray Rock Mining Company, reputed subsidiary of the Newmont Mining Corporation, has provided complete equipment and is sinking a new shaft on the Elkoro mine, at Jarbidge, northern Elko County, to explore below formerly productive tunnel workings. John Becker is in charge.

▶ The cyanide circuit of the new 600-ton mill of the Getchell Mine, Inc., is in successful operation and the sulphide roasting department is ready for firing. Heavy storms and snow-blocked roads delayed the start of the plant. Space in the mill structure is provided for a tungsten plant, large deposits of scheelite having been found on the 18,700-acre property, situated in eastern Humboldt County. N. H. Getchell is vice-president and manager and George Wingfield is president.

▶ The 50-ton cyanide mill of the Penelas Mining Company, in the extreme north end of Nye County, is treating gold ore of excellent grade and has yielded a consistent profit since it was started just two years ago, according to a report by L. D. Gordon, president and manager. Two veins, the Penelas and Victor, provide ore that is mined by the shrinkage method of stoping. The mill is diesel-powered, as are pumps that supply water through a 6,000-ft. pipe line.

ARIZONA

Molybdenum Prospecting in Yavapai County

Encouraging results reported from diamond drilling—Pocahontas mine, in Eureka district, being reopened—Custom smelter planned at Nogales

▶ The Ohio Ferro-Alloys Company, of Canton, Ohio, reported to be affiliated with the Timken Roller Bearing Company, has been drilling the Copper Hill property in Copper Basin, Yavapai County, for molybdenum. It is reported that good ore has been found down to 300 ft., but loose earth has been causing trouble in keeping the holes open. The Copper Hill group is held under option by Richard Kingdon, of Prescott, Ariz.

▶ Walter S. Larssen, of Congress Junction, is directing the reopening of the old Pocahontas mine, in the Eureka district near Kirkland. It is reported equipment will soon be installed. J. Ben Ross, of Phoenix, Ariz., is trustee for the Texas group which acquired title to the property in October, 1937.

▶ J. P. Woodward and associates, who own the Viking mines, situated in the Lone Star district 9 miles north of Safford, Ariz., report having opened up a 6-in. vein carrying values of $50 in gold, silver, and copper.

▶ Wirt G. Bowman, Nogales, Ariz., president of the Southwestern Smelting & Concentrating Company, is said to have received authority for the issuing of 66,000 shares of the company's stock at $5 per share. The proceeds will be used in the erection of a custom smelter and concentrating plant at Nogales.

▶ The Hassayampa River Mining Company is now operating two shifts at the Charles Lawson property. R. C. Stoner, of Mayer, Ariz., is manager. The general offices of the company are in Santa Barbara, Calif.

▶ The American-Kirkland Gold Mines, Inc., of Kirkland, Ariz., announce the Federal Power Commission has authorized the construction of a new power line to serve the property. Dr. Hugo Carl, of Kirkland, is directing operations.

▶ A third shift is expected to start soon at the Barmore Mines, Inc., of Tombstone. The company holds a lease and option on 55 claims owned by the Gallagher Vanadium & Rare Metals Corporation and the Mellgren Mines Corporation. Ore from the property is being treated at the Gallagher mill. R. O. Moore, president, and Harry Ginsberg, vice-president, have established headquarters at Tombstone.

▶ The Universal Placer Mining Corporation, of Blythe, Calif., is reported to have moved its 1,000-yd. dry placer plant to the Rich Hill district near Octave, Ariz. James H. Kennedy, of Blythe, is general manager.

▶ A new cyanide plant is being constructed by the Liberty Hill Gold Mines, Ltd., at the Alvarado mine, 5 miles north of Congress Junction, under the direction of L. L. Farnham. R. P. M. Davis, 6715 Hollywood Boulevard, Los Angeles, is president of the company.

▶ The Gold Dike group of claims situated in Lonesome Valley between Prescott and Jerome has been taken over by the Gold Dike Mining Company. Howard H. Fields and T. J. Byrne, of Prescott, are the incorporaters.

▶ Operations at the Clifton smelter of the Phelps Dodge Corporation were suspended on March 7. H. M. Lavender is general manager.

▼

Bureau of Mines Research Fellowships

▶ In cooperation with the Bureau of Mines, the University of Maryland offers three fellowships of $600 each for research in metallurgy, non-metals, and mining, for a period of twelve months from July 1, 1938. Fellows will register in the graduate school of the University as candidates for the degree of doctor of philosophy, and will divide their time between instruction and research. Applications will be received up to April 1, 1938. Further information can be obtained by addressing Fellowship Committee, Eastern Experiment Station, Bureau of Mines, College Park, Md.

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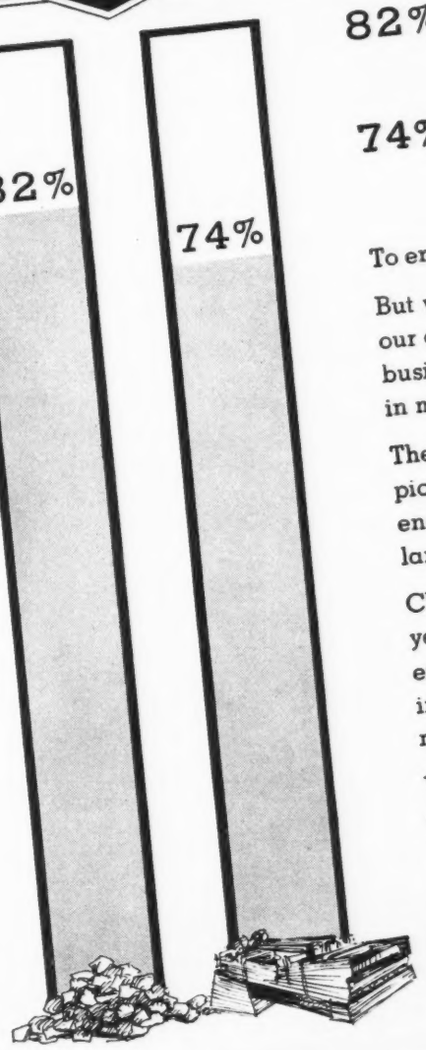

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Ohio Copper Company, of Utah, is treating about 1,600 tons of copper tailings per day that are hydraulicked to the mill and delivered to a series of Devereaux type agitators to which is added shredded iron

UTAH

Grand Central Mine Begins Shipping Siliceous Ore

About 3,000 tons being mined per month for Garfield Smelter—Utah Copper vehicular tunnel holed through midnight Feb. 20—International Smelting Company curtails operations

▶ Rehabilitation of the old Grand Central mine, at Mammoth, by the American Smelting & Refining Company was followed by the beginning of shipments. Siliceous ore, containing gold, silver, and copper, is being mined at the rate of 3,000 tons monthly from the stopes between the 700 and the 2,100 level and shipped to the A. S. & R. plant at Garfield. About 40 men are employed. Instead of the 9,000-ft. tramway used by former operators, the company built a 2,300-ft. railroad spur to the Grand Central dump and drove a 1,000-ft. tunnel to connect with the 250-ft. level. Ore is hauled in the tunnel with an electric motor car. J. Fred Johnson, A. S. & R. engineer, is supervising operations and William J. Coombs is resident superintendent.

▶ Officials and employees of the Utah Copper Company, and the Utah Construction Company, contractors, celebrated the "holing through" of the 7,000-ft. vehicular tunnel on Feb. 21. This tunnel, connecting Carr Fork, in Lower Bingham, with Copperfield, is 16 ft. wide by 18 ft. 2 in. high. The north and south adits were "holed through" about midnight of Feb. 20. Another three months will elapse before the final completion of the tunnel for use by pedestrians and motor vehicle traffic.

▶ By a ratio of four to one, members of the International Union of Mine, Mill, and Smelter Workers refused to ratify the tentative wage and hours contract offered by a committee of employer-employee representatives. This contract is to replace the one which expired Dec. 31, 1937. Its terms seek to put into effect a base wage of $4.25 daily, with a sliding scale corresponding to the price of lead, copper, and silver. On the return, early in March, to Salt Lake City of James W. Wade, spokesman for the employer group, negotiations will be resumed. In the meantime, operations continued normally at mines, mills, and smelters pending the settlement of differences.

▶ Utah Copper, based on two times the 1937 net proceeds, reported an assessed valuation for taxation purposes of $61,252,450 for 1938. Last year, based on three times the net proceeds, the company reported a tax base of $44,711,535. The 1937 State Legislature changed the basis for taxation of nonferrous metal mines to twice the net proceeds plus an occupational tax of 1 per cent of the gross proceeds. Metal mines also pay tax on the value of real estate and equipment.

▶ The Park Utah Mines Company settled out of court its controversy with the Park City Elmira Mining Company over ownership of the Summit claim, near Park City, and long considered a part of the Park City Utah estate. Judge Tillman D. Johnson of the United States District court signed the order dismissing the suit of the Park City Utah Mines Company to quiet title. Terms of settlement were not revealed. When the controversy started, three years ago, the Park Utah Mines Company stopped operations.

▶ Examiner P. H. McNally, of the National Labor Relations Board, held in his report on the complaint filed by the International Union of Mine, Mill and Smelter Workers that the Utah Copper Company had "coerced and restrained" its employees to get them to join the Employees Central Committee and to keep them from joining the C.I.O. affiliate. Immediate steps were taken by the C.I.O. union to push its membership campaign at the Bingham, Arthur, and Magna mine and mills of the company. D. D. Moffat, vice-president and general manager, announced that the company would resist the adoption by the National Labor Relations Board of Examiner McNally's recommendations now before the Washington, D. C., body. Officers of the union announced that the report was a "sweeping victory for organized labor in the first case tried in Utah before the National Labor Relations Board."

▶ Employees at the Tooele smelter of the International Smelting Company were placed on Feb. 1 on a six-day a week basis and at the mill operations were reduced from 25 days to 15 days a month, laying off approximately 70 men in both plants.

MONTANA

Miners Concerned About Rise in Copper Stocks

Production on curtailed basis may be cut further if conditions fail to improve—Mapleton mine ships high-grade gold ore

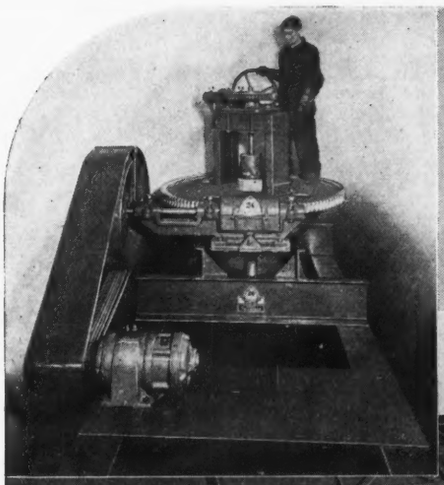
▶ According to word from Virginia City, two carloads of high-grade gold ore have been shipped from Mapleton mine by its owner, W. J. Batten. Other current high-grade shippers in Madison County include J. C. Frisbie, at the Lexington mine, in the Revenue district, and Jacob Steiner, of Sheridan, operating the Goldsmith mine. News has also been received that work has been in progress during the winter at the Twin Lakes mine, at the head of North Meadow Creek, by the owners, the Frisbie Brothers, of McAllister.

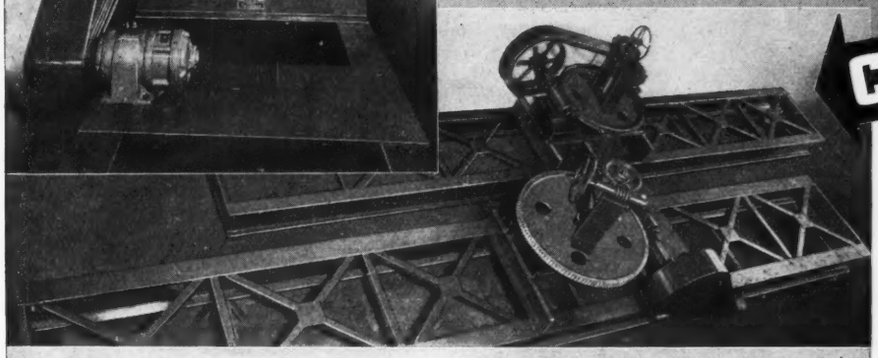
▶ Stockholders of the Jack Waite Mining Company, whose property is operated by the Federal Mining & Smelting Company, received a dividend of 1½¢ a share on Feb. 22. The payment totaled $141,316. The property lies partly in Montana and partly in Idaho and is under the management of H. G. Washburn, of Wallace, Idaho. It produces lead, zinc, and silver ores, which are concentrated at the company's mill on the Idaho side. The products are then trucked through Murray to Nine Mile for shipment to refineries—lead to East Helena and zinc to Great Falls, Mont.

▶ The six weeks' course in mining which for the past five years has been given at the Montana School of Mines for practical miners and prospectors is not being given this year, owing to a shortage of funds and equipment facilities at the college, which is overtaxed by a large enrollment.

▶ General production at Butte has remained unchanged during the past thirty days. The continued rise in surplus copper stocks, however, has given rise to additional apprehension concerning maintenance of the current rate, which already represents a rather drastic deduction.

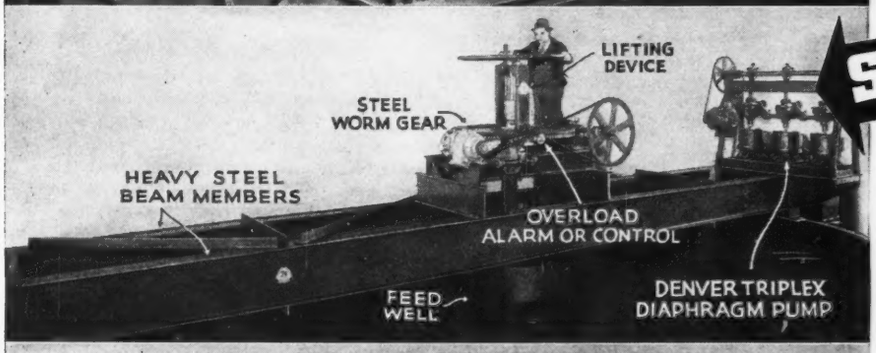
Why Large Companies use Denver Thickeners





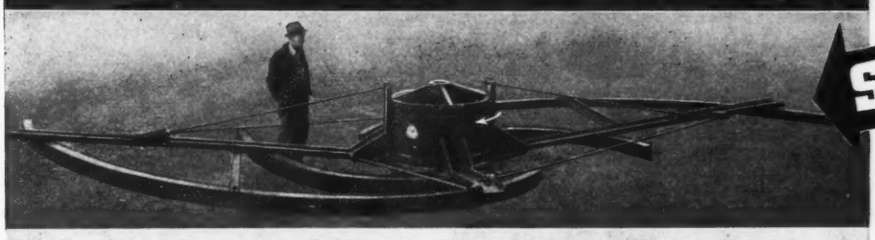
Cut Steel Gear

CUT STEEL MAIN gears for Denver Thickeners are three times as strong as ordinary cast iron gears; worm gears are made of phosphorus bronze. The main gear operates on a thrust type ball bearing which takes the entire load. All Denver Thickeners, forty foot and larger, have a positive worm gear lifting device.



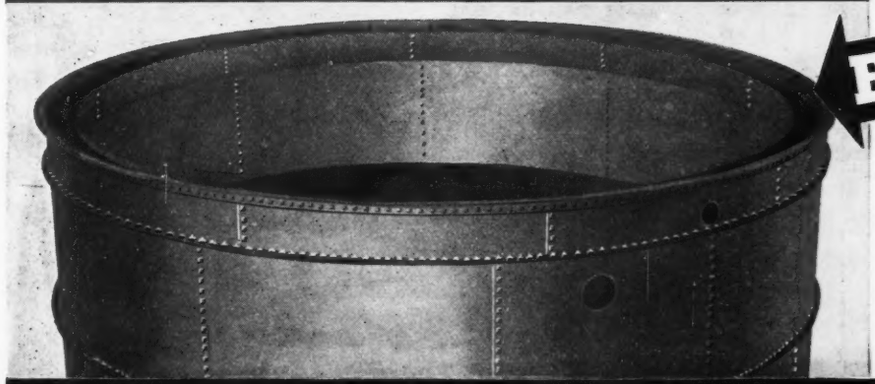
Strong Design

LOWHEAD BEAM superstructure permits minimum head room and is considerably more compact than conventional bridge truss superstructure. This unit consists of two heavy structural steel members . . . with cross braces all rigidly welded or bolted together; shaft assemblies will withstand severest overloads.



Spiral Rakes

THE EXCLUSIVE spiral rakes convey material to center cone in one revolution, thus giving increased capacity.



Bolted Tanks

LEAK - PROOF Denver Bolted Steel Tanks are ideal for thickener tanks because they are built in sections. Washing tray tanks are accurately fabricated and easy to transport and install. Bulletin No. 3814.

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NEWS FROM Washington

By Special Correspondent

WASHINGTON STRUGGLES with three "most important" subjects — international relations, budget problems, and aids for business. All three are forced on the Administration attention, and are crowding reform off to one side. But the desire for reform has in no measure abated.

No novel form of business assistance to offset recession factors has been discovered. Even the two expected major aids (tax revision and housing subsidy) are being pressed slowly or ineffectively. Meantime, R.F.C. has been instructed to man a bucket brigade for pump priming of small business, using its balance of a billion and a half dollars. This is obviously the major immediate result of the Little Business Men's conference.

Monopoly Fight Slows

IT IS OPEN SEASON in Washington for any monopolistic practice. The guns of Federal Trade Commission are barking daily with complaints and orders to cease and desist. But little progress on the President's promised program of legislation was made during February. Little more is expected soon.

Probably most important of all the efforts against bigness is that which centers around the enlargement of the authority of Federal Trade Commission. That body is going to have additional privileges in both initiating investigations and enforcing orders. Much of this will continue in the field of "unfair competition" studies. But in addition all industry can expect drastic applications of the law against practices that tend to encourage bigness in business.

Definite progress is being made by F.T.C. in its control of advertising and merchandising policies. Shortly it is expected to have control of food, drug, and cosmetic advertising, and then orders even more vigorous than those now forthcoming under the Robinson-Patan Law are certain.

Congress has not succeeded very well in carrying out the President's ideas regarding concentration of wealth. Use of taxation as a means for offsetting close control of business enterprise is proving extremely difficult, and may not be accomplished at all successfully. Each rewrite of the new tax law weakens the reform aspects.

Capital Hill Worries

CONGRESS is very unhappy. Everything on which it is asked or forced to vote is unpopular with some block of constituents. That is a woeful situation in a pre-election session. And, worst of all, riding on the President's coattails may be dangerous rather than helpful in many Congressional districts.

This over-simplified statement of the Congressional situation perhaps explains as well as any single factor why it took three months to pass any farm bill, and why the resulting bill is an uninterpretable jumble of weird ideas. It also explains the willingness of the Senate to be held off of important legislative matters by the lynch-law filibuster. As long as that lasted, votes on other delicate questions could be avoided.

Even the usually harmless votes on appropriation bills are occasionally difficult. As a consequence, Congress is in a very generous spending spirit, despite its consciousness that economy would be good for the country. The budget message of January is, therefore, already discredited and sadly out of line with fiscal expectations. Tending toward enlarged deficits will be:

1. Greatly expanded naval program.
2. More loans through R.F.C.
3. Difficulty with any tax bill, for, regardless of the form of revisions, tax income next fiscal year will be less than last, from many sources.
4. More relief demands, including $250,000,000 for the rest of *this* fiscal year and probably a half billion more next year than the budget provided.
5. Generous spending for all administrative departments, as most of these help with back-home patronage.

The urgent need to get home and rebuild political fences will be the only thing that will terminate the present session of Congress before the dogdays. The chatter about May 15 adjournment is not convincing, even though such date would be most welcome to those Congressmen who have difficult primary problems to solve.

WHAT BUSINESS WANTS

THE CONFERENCE of "Little Business Men" was highly educational, as well as somewhat entertaining, for Washington. In shocked surprise, important Administration leaders learned that little fellows want the same things that big ones do. Spokesmen for the "Sixty Families" could hardly have done better in writing their wants in Washington than did this Roper-called, but Roper not-managed, conference. Only the rather mild criticism of monopoly gave any encouragement to New Deal reformers.. Every other major bit of legislation to correct the evils often recited by New Dealers was criticized either directly or by implication.

DESPITE the obvious aversion of all business, big and little, to fixed Federal labor standards, the President is insisting that some measure of this character be taken up and passed by Congress. No one knows whether he will get any kind of a bill at all, even a face-saving measure. Most Congressmen would prefer not, but there is plenty of reserve pressure in the political bag for use in a pre-election season. There is not the same conscientious-objection basis for a battle as there was in the Court-packing fight.

ULTIMATELY some kind of a tax revision bill will be enacted. Business should not be unduly discouraged. It took twelve months to a day from introduction to signature on the farm bill, and for three months of this period it was the major business of Congress. When politically helpful measures are so slow, those politically doubtful in the minds of the Congressmen cannot be made speedy.

To Cut Patent Life?

MONTHS AGO *E&MJ* reported the sighting of trial balloons flown by Assistant Attorney General Jackson and others, proposing that patent rights be curtailed because they were used to create monopoly. In his message to Congress in January, the President officially announced his adoption of that philosophy, practically promising patent reform as a part of his anti-monopoly crusade.

Late in January it became evident that the compulsory licensing of patents was to be the major means of attacking these monopoly-making rights. Even then very few seemed to take the matter seriously. But perusal of the measure, which has some semblance of Administration backing, is expected to stir business more seriously. The bill in question will probably not pass "as is;" but in it Representative McFarlane of Texas shows the trend of reform thinking.

This bill (H.R. 9259) proposes in substance that the exclusive use of the patent be restricted to three years after issue. Thereafter anyone seeking a license under the patent would apply for this to the Commissioner of Patents, who would determine the applicant's financial responsibility and the public interest that might be served by granting such a license. If such responsibility and public interest were affirmatively determined by the Commissioner, the license would be granted under specific terms and conditions which the applicant would propose. Then if the patentee objected to these terms he would have to enter protest before the Commissioner, whose decision would be subject to review by a Board of Appeals consisting of three individuals. This board, named by the President with the consent of the Senate, would consist of one attorney, one engineer, and one economist. Its review would be subject to further appeal to the United States District Court.

No one should expect that these specific terms will be found in any final legislation, but they are important as

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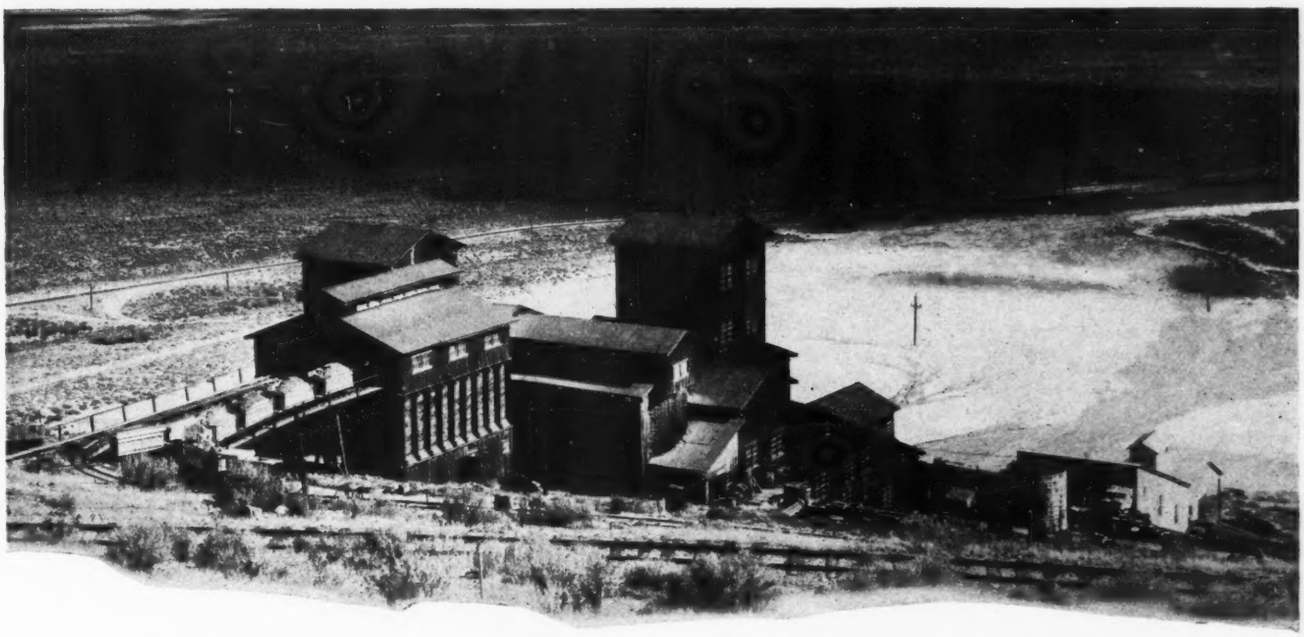

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Writes MR. OTT F. HEIZER, General Manager

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This installation indicates the wide range of particle size successfully treated by the Agitair Flotation Machines. It also illustrates the Agitair's success in making one of the most difficult separations of minerals.

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representing the point of view which certain Administration leaders are taking with respect to patent rights. There is no means of gaging how much pressure the Administration may put back of these ideas, nor what the Congressional reaction might be. Nevertheless, the trend of thinking is significant and dangerous for business.

International Problems

RESTRICTIONS on mineral rights provided by the new Brazilian Constitution are now fully disclosed in summaries released by the Bureau of Mines. It appears that nationalization is not to proceed in retroactive form for expropriation of old legal claims. Furthermore, the steps which may be taken for nationalization in the future are rather clearly defined. But mineral deposits not fully proven and reported to the authorities by owners are now the property of the Government, either Federal or State as the case may be. Also significant in restricting *further* mineral development in Brazil is the requirement that Brazilian capital and ownership must dominate.

Strategic mineral questions continue to have the attention of Congress. The Senate is struggling mightily in an effort to determine how scrap metals may be controlled, and using questions regarding secondary metals as a basis for an extended inquiry into international mineral economics affecting the United States. The trend of thinking and probable result remain in doubt. Establishment of the proposed board for strategic materials seems unlikely.

Vastly more significant to American mining industry than any legislation are the negotiations with Britain and Canada, which are bound to cut further tariffs. Mr. Hull's policy is to reduce tariffs. Associations representing the lead and zinc mining industries, respectively, will make strong protestations against any threatened tariff reductions on zinc and lead ores or their products.

Alaska Mineral Policy

DISCUSSING Alaskan resources and development, the "Planners" of National Resources Committee have, for the first time, revealed rather fully their thinking about mineral policy. It is not unreasonable to assume that, within the limits of Federal control, they would apply in continental United States the same general ideas which they set forth for this Territory. That they want a conservation policy, and that they want a retention of control by the Government, is not surprising. The implied recognition that private industry must do the development, if it is to be accomplished, is decidedly more unexpected.

In its report to the President, transmitted about Christmas and released late in January, the Committee recognizes a distinction between possible reserves of strategic minerals and those solely of commercial concern. Although urging studies to determine whether antimony, chromium, manganese, nickel, or tin might not be developed there, these "Planners" are anything but impatient about other mineral reserves, saying, "Solely as a means of advantageously completing its economy in time of peace, the United States has no real need for raw materials that Alaska resources may be able to provide, although if such raw materials can be produced in competition with world supplies without governmental subsidy, this may be economically desirable."

The major recommendation of the report, probably enthusiastically supported by most of mineral industry, is: "In any event, it would seem to be the part of wisdom to speed up the geological exploration of the mineral resources of the Territory and to map them with the greatest speed, in order that it may be learned whether or not Alaska possesses any considerable store of strategic minerals in addition to those already known."

In its mineral recommendation the Committee raises one question as to the desirability of active mining in this Territory. It says: "Any stimulus or encouragement to one industry, assuming that this may be justified in the national interest, will tend to benefit others. Certain developments unrelated to mining would follow an expansion of mineral exploration. Mining, however, unless it is of the lode type, tends to break down the objective of permanent building in compact areas involving a full utilization of resources." This, from the context, is clearly intended as a criticism of "over-aggressive" gold exploitation, which, the Committee says has included exploitation of labor and of the natives.

Recognizing that a tax program for Alaska may be made the means of indirect control, the Committee makes an important policy statement. It generalizes thus:

"In any event, yield or severance taxes if adopted for the purpose of accumulating capital should be made very substantial, although not so heavy as to discourage unduly salmon canning or mining. The taxes should not be heavier in any event than is necessary to collect the maximum amount of revenue. Whether existing taxes are already heavy enough, too heavy, or too light, the Committee is in no position to say. . . . The revenue thus accumulated should be looked upon as capital for the development of the country rather than as income to meet the current expenses of the government."

Hitler Looks East

DEVELOPMENT of German control eastward is for industrial and mineral resource purposes. Social and political considerations are secondary. Gaining mineral supplies vital for the Reich is perhaps the dominant reason for present moves.

This interpretation could not be officially confirmed in Washington without confessing a mercenary attitude quite at variance with the Hull international policy. But apparently this interpretation is taken seriously in high places. It is understood to mean that Germany is merely taking one more step toward establishment of a broad eastern corridor which will ultimately reach to the Black Sea, with dominance as far around as the Caucasus. Hoped for in this program are bauxite from Hungary and Jugoslavia, copper from Jugoslavia, more zinc from Silesia, iron and coal from the Ukraine, manganese from Georgia, and oil from both Rumania and the Caucasus.

Unofficially, Washington believes that British trade interests like this trend. Increasing the strength of the Reich in that direction will relieve German internal pressure, without threatening either British sea control or former German colonies now British mandated. It will strengthen the industry of the Balkans, but will put it on high labor level. Thus the burden of new competition will not be made too heavy.

The result cannot be compared in seriousness with the threat of Japanese dominance in the Orient with new Asiatic resources. The Oriental labor supply available to Japanese for mining and agriculture, as well as for manufacturing, is far more serious threat to British trade. In fact, German domination of the Balkans might actually lessen the price pressure on British goods. This is the opposite effect that any Japanese success would have. Whatever the outcome, the mineral industries are basic in the whole movement.

MONEY MANEUVERS

MORE INFLATIONARY influences are being exerted by the Administration on both goods and fiscal situations. The President, in urging higher prices, as he did in mid-February, denied that he wanted any general inflation, or that the rise in prices would be of that effect. But every orthodox analysis still follows the interpretation given earlier by E.&M.J. (see E.&M.J. February, page 98, "Metal Prices"). Three outstanding factors of February deserve notice:

1. No more imported gold will be sterilized, unless the influx exceeds $100,000,000 each quarter. Even $30,000,000 of gold already in the Treasury is released from the inactive fund. The result is a broader commercial credit base and, more important politically, a lesser need for the Treasury to borrow funds.

2. The R.F.C. is to renew commercial loans, especially to small businesses. Funds available without new legislation are at least $1,500,000,000.

3. The President urges that higher prices be established. He tries to distinguish between prices for goods sold by producers (whom he seeks to boost) and market-basket prices (which he seeks to protect against rise). But there is no evident means for preventing price inflation on consumers' goods after raw materials prices are forced up.

OFFSETTING these inflationary influences, which should, and normally would, stimulate equity values in both commodities and securities, are the threats of narrowed profit margins. Thus the failure of the stock market to react favorably to normally "bull" factors is explained by those who study Washington closely.

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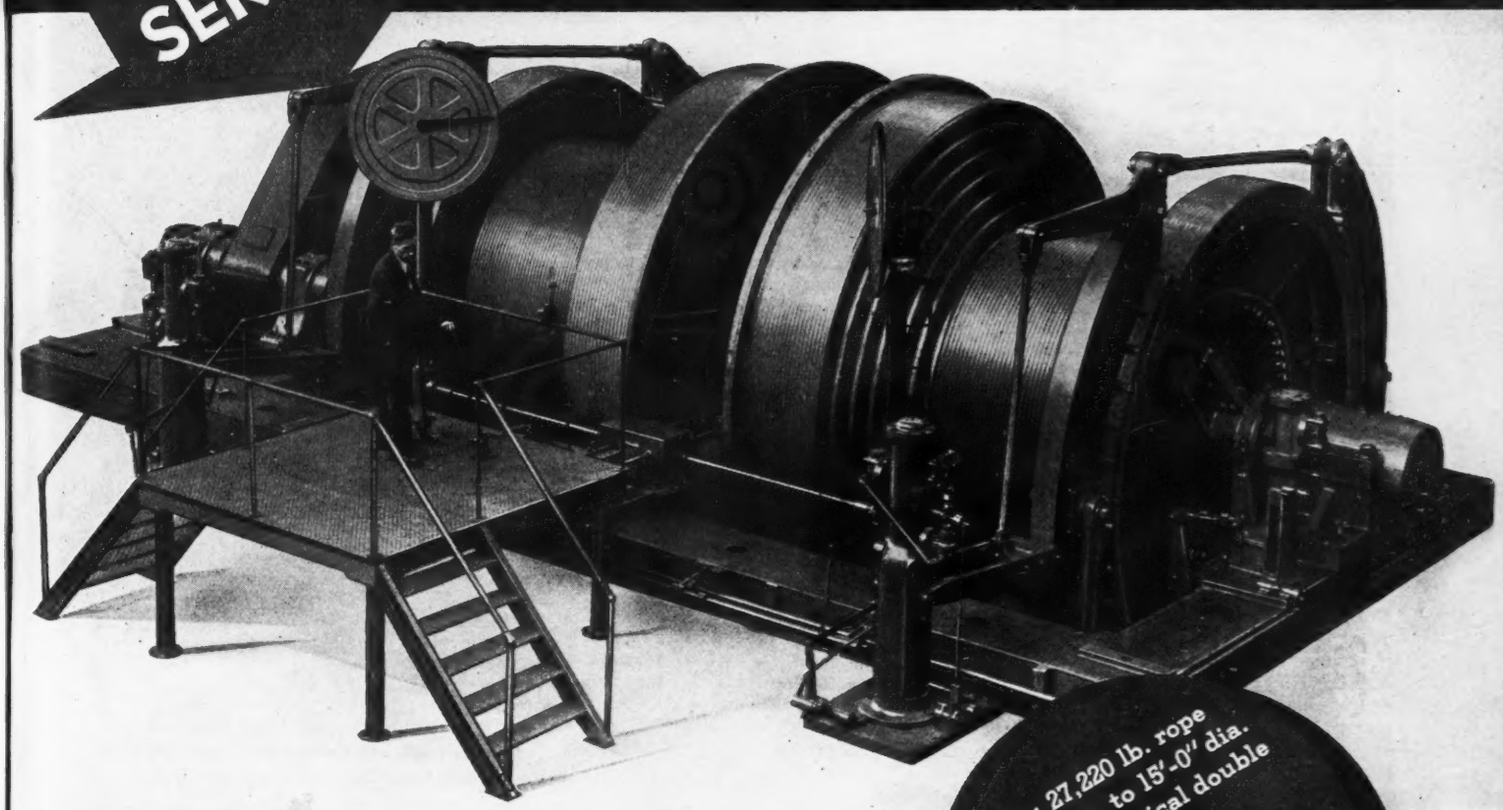
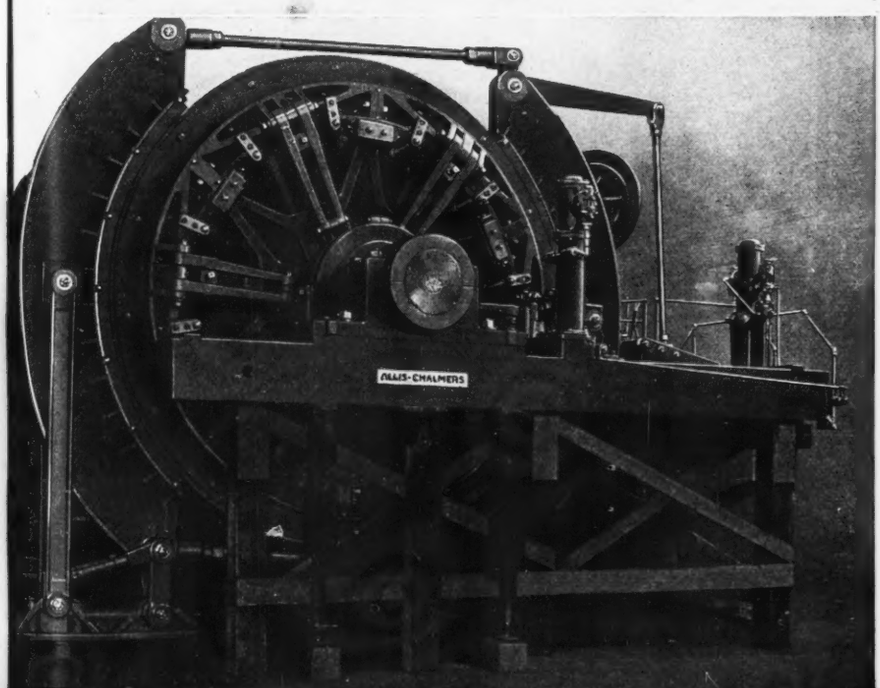
FOR COAL OR METAL MINES



Above: 27,220 lb. rope pull 9'-0" dia. to 15'-0" dia. Bi-Cylindro-Conical double Drum Hoist.

Left: Double Drum Mine Hoist—50,000 lbs. rope pull from 4,500 ft. at 2250 fpm. maximum.



Allis-Chalmers builds mine hoists to solve every hoisting problem from that requiring a small friction or electric hoist to hoisting 50,000 lbs. or more a lift at 3000 fpm. Allis-Chalmers also builds electric drives and control for all sizes of hoists. ***Write for Bulletin 1830.***

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EQUIPMENT ENGINEERS TO INDUSTRY

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A.I.M.E. Meeting Attracts Many in Spite of Recession

Papers presented covered a wide range of metallurgical subjects—Medals are presented to Hal W. Hardinge and Henry L. Doherty

CONVENING at the 148th meeting in New York City Feb. 14-18, members of the American Institute of Mining and Metallurgical Engineers came from many parts of United States, Canada, Mexico, and South America, and total registration slightly exceeded that of last year. Technical programs devoted to problems in the coal, oil, and steel industries especially attracted many from the Eastern and Central States. Conversations between and among members and groups covered a wide field of topics, chief of which, however, was the business recession, and what the prospects were for improvement in mining and other industries.

Following the formal meetings on Monday morning, which were devoted to Mining Methods, principally in the nonmetallic fields, and papers on aërial geologizing and non-ferrous metallurgy, members attended a general session of the Institute and heard two outstanding speakers discuss present-day problems. Dr. Harold G. Moulton, president of the Brookings Institution, discussed "Interrelations of Technology, Economics, and Government in a Balanced and Progressing Economy." He challenged the view of persons who would solve the unemployment problem by shortening hours of labor and curtailing technological advances. He said, "Only by everlastingly improving technical processes and lowering cost of production can we obtain progressively higher standards of living. To try to accomplish this result in any other way means simply tugging in vain at our collective bootstraps." Dr. Leo Wolman, of Columbia University, one of the country's leading authorities and students of labor problems, spoke on "Labor and Capital." He said in part:

"Unwise terms of our law of trade unions and the unbridled zeal of its administrations show some signs of being revised in the light of experience and the protests of the law's own beneficiaries. At the point where labor policy touches economic conditions, the two powerful factions of the American labor movement appear to look with a less friendly eye on the bewildering succession of economic experiments and to have a deep nostalgia for a simpler and more prosperous economy. . . . The conditions of labor we have latterly put in effect in this country seem to depart from accepted standards of moderation and reasonableness. They are gaged to the conditions of business at the peak of booms and as such may successfully prevent improvement in business when industry is on the rise and may fail to arrest the fall when industry is in a decline."

Members enjoyed the ample and diversified entertainment at the annual smoker held at the Waldorf-Astoria on Monday night, Feb. 14. Sessions, on Tuesday morning were devoted to papers on mine ventilation and air-conditioning. Speakers were Willis H. Carrier, of Carrier Corporation, Syracuse, N. Y.; and A. S. Richardson, ventilation engineer, Anaconda Copper Mining Company. Other meetings discussed papers on milling methods for non-metallics and blast furnace practice. Tuesday afternoon Leroy V. Gardner, director of Saranac Laboratory, explained numerous slides that illustrated in microscopic detail the reaction of the lungs to different types of dust, with and without infection in humans and in animals. Donald E. Cummings, assistant director of the Saranac Laboratory, discussed suggested standards for the control of silicosis hazards. Papers on properties and uses of nonferrous metals were given by John B. Baker, a professor at Drexel Institute; Benard B. Betty, International Nickel Company; and H. F. Moore, a professor at the University of Illinois. C. F. Smart, metallurgist, Pontiac Motors Division, General Motors Corporation, described an important new use of indium. Electroplating a very thin layer of indium on the surfaces of automobile bearings prevented corrosion from acid, formed in petroleum lubricants at the high temperatures developed in internal combustion engines. Calcium metallurgy was discussed by C. L. Mantell, consulting engineer, and Charles Hardy, president, Charles Hardy, Inc.

Discussion on Wednesday centered on milling methods, mining geology, and non-ferrous metallurgy. A paper by R. E. Head, microscopist, United States Bureau of Mines, described mineralogical characteristics affecting the concentration of a semi-oxidized lead-silver ores. Grindability and grinding characteristics of ores were described by F. C. Bond and W. L. Maxon, Allis-Chalmers Manufacturing Company. W. M. Stephen, assistant mill superintendent International Nickel Company of Canada, presented a paper on "Mesh Grinding in Closed Circuit With Stainless Steel Screens." C. H. Rose, mill superintendent, International Nickel Company, Copper Cliff, Ontario, discussed the use of screens in closed circuit with ball mills. Among the papers on non-ferrous metallurgy were "Adherence of Cathode Zinc deposits to Aluminum Sheets," by H. R. Hanley and C. Y. Clayton, Missouri School of Mines and Metallurgy; and "Investigation Into Anode-furnace Refining of High-Nickel Blister Copper," by F. Benard, plant manager, Ontario Refining Company, Ltd. Leonard Larson, general superintendent reduction plant, Nevada Consolidated Copper Corporation, described the remodeled smelter at McGill, Nev., for direct-smelting practice.

Attendance at the annual dinner, held at the Waldorf-Astoria on Wednesday, Feb. 16, exceeded last year's by about 200 persons. R. C. Allen, president in 1937, acted as toastmaster and presented medals and honors to the following: The James Douglas Medal to Hal Williams Hardinge, who is 82 years old, for "his inventions of apparatus for fine grinding of ores and achievements in improving practice in that art." The Anthony F. Lucas Medal to Henry L. Doherty, "for his recognition of the importance of solubility of natural gas in crude oil and his early advocation of scientific production of oil fields from the standpoint of energy conservation." A certificate of Honorary Membership was awarded to John Van Wicheren Reynders, "for his achievements as a maker of steel; for his effective service to society and to the engineering profession; for his inspiring leadership in the affairs of the Institute." The Robert W. Hunt prize for 1938 went to Thomas S. Washburn and John Hunter Nead for their paper on "Structure of Rimmed-steel Ingots." The G. E. Johnson, Jr., Award was presented to Roy Alexander Lindgren, "for meritorious study of the performance and selection of refractories for blast-furnace linings." Daniel C. Jackling, director of Kennecott Copper Corporation, was introduced as president of the Institute for 1938, by Rolland C. Allen, outgoing president.

IRON COUNTRY

Butler Brothers Close LaRue Mine

Many companies operating on three- and four-day week basis—Operators anticipate gradually improving conditions and a fair year's business

▶ Winter mining and repair work continues at a minimum rate at various properties on the Mesabi range. With the consumption of iron ore running under two million tons per month, operators are skeptical of doing much of anything until spring at least. The Oliver Iron Mining Company and Pickands Mather have announced a reduction in the working hours of the salaried men from five and one-half days to five days, or forty hours, per week. This means a reduction in earning capacity of about 9 per cent. Practically all operations, both underground and pit, are now on either four or three days per week basis. No change has been made in the rate of wages, and with meetings on with the labor chiefs at this time, no change is expected. It is the belief among the operators that conditions will improve during the early summer and that a fair year will be experienced.

▶ Butler Brothers have closed the LaRue mine for an indefinite period. J. A. Stampe is superintendent of this property. This mine is an underground operation using conveyor belts to remove the ore and the product is treated at the washing plant as it is mined in a crude state.

▶ A new 120-B Bucyrus Electric Shovel has just been assembled at the Danube mine, at Bovey, Minn., and is now in operation.

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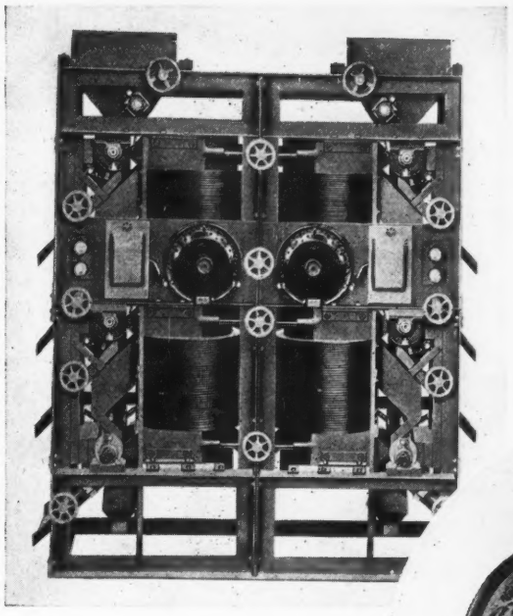

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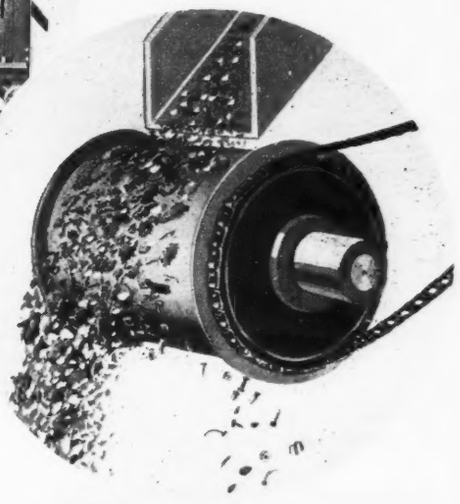

Above: Type I. R. High Intensity Magnetic Separator. The most powerful separator in the world. Will efficiently remove iron oxides, garnet, mica and other weakly magnetic substances. Built in one or more stages necessary to meet every separation or concentration requirement.

Circle: Drum type separator—Will remove deleterious iron of fine or coarse size. Extensively in use for crusher and grinder protection against tramp iron and the concentration of such minerals as iron and nickel ore.

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IDAHO

Base Metal Producers Sharpen Curtailment

Low zinc price forces suspension of operations of Star mine—Lead stock climb at smelter—Shaft cave-in reported at Morning mine—Silver mines active

▶ The severe slump in the base-metal markets is taking its toll in the Coeur d'Alene mining district. The Star mine of the Sullivan Mining Company, at Burke, ceased production, all but 75 of the crew of 320 miners and millmen being laid off. The decline in the zinc market, chief product of the Star, prompted the company's decision to shut down, according to L. E. Henley, mine superintendent. The Interstate mine of the Callahan Zinc-Lead Company has curtailed operations and will confine work to development in the upper levels of the mine. A small number of the regular crew of 60 miners will be retained. Interstate is a zinc producer. The Callahan company will continue development at its Galena mine and Vulcan holdings, according to Manager Frank Eichelberger. The company has recently acquired extensive placer gold holdings in the Fairbanks district of Alaska, where extensive operations are planned. Other large producers in the district are maintaining operations but are being handicapped by accumulation of large stocks of metal. Bunker Hill & Sullivan, at Kellogg, has about 1,600 men on the payrolls. The Page mine of the Federal company has cut to a five-day week basis. The Morning mine, closed temporarily on Jan. 28 when a portion of the shaft at the 1,850-ft. level caved in, is again in operation with its full crew of 600 men at work. One miner, Jacob Maki, 57, lost his life in the shaft accident. The Hecla, Polaris, Sunshine, and Crescent will have no interruption of output, being chiefly silver producers.

▶ Hope Silver-Lead Mines, Inc., at Clark Fork, has shipped a total of $126,651 worth of lead-silver ore to the smelter during the past two years of operations, according to Albert Nash, of Kellogg, manager. The mill has been handling 65 tons per day but will be stepped up to 150 tons in the near future.

▶ Silver Crescent, Inc., expended $61,988.98 in exploration and development work at its property in the Moon Creek district during the past year. Guy E. Riegel, of Spokane, is president of the company; Stanley M. Brown, vice-president; Clyde B. White, managing director; and H. Webster Hancock and Frank D. Garrett, directors. Future plans call for an alteration of the mill to handle the tungsten content of the lead-silver ore.

▶ Reports of an important ore strike at the property of the Rainbow Mining Company on Evans Creek, near Medimont, were made the week of Feb. 17. High-grade galena was showing in the face of the drift at a vertical depth of 900 ft. The crosscut and drift have been extended 4,700 ft. toward the objective point, where diamond drills indicated an orebody. The ledge is said to have a width of 40 ft.

▶ The Mackay-Lamb mine, in Idaho County, has been acquired by the Buffalo-Idaho Mining Company, according to Stewart Campbell, consulting engineer for the company. Entirely new machinery, including a diesel-driven compressor, a hoist, and a pump, will be installed immediately. Campbell said that $20,000 was produced from the old workings when the price of gold was $20.67 an ounce and extraction made with a small four-stamp mill. A new mill is also planned. Brott & Templeton, of Buffalo, N. Y., are financing the project.

▶ Sunshine Mining company reported ore reserves totaling 450,000 tons, of which 235,000 tons are below the 2,300-ft. level, indicating ore reserves adequate for the next two years without further development work. Manager Leisk has set 12,000,000 oz. of silver as the goal for 1938.

▶ Metropolitan Mines Corporation, Big Creek district, is shaft sinking from the 400-ft. level to the 600 level to intersect the No. 4 vein. The shaft is down 70 ft. Encouraging results were found in a flat ore stringer showing assay returns of 54.2 per cent lead, 32 oz. silver, 8 per cent copper, and 0.12 oz. gold. R. S. Merriam, of Wallace, is manager.

▶ Coeur d'Alene Mines Corporation has passed the 400-ft. mark in its shaft-sinking operations in the silver belt. The shaft will be sunk 1,000 ft., where an extensive exploration program will open several vein systems known to exist. Joe Grismer, of Wallace, has charge of the work.

▶ Gibbonsville Mining & Exploration Company, at Gibbonsville, has let a contract to R. A. Schultz, of Wallace, for open-pit mining of 200 tons of ore daily when the new mill is in operation. The ore contains gold, silver, and lead. Concentrates will be trucked to the Bunker Hill smelter at Kellogg, a distance of 250 miles. Philo Seelye, of Gibbonsville, is president.

▶ Employees of the Bunker Hill & Sullivan mine have established a credit union at Kellogg to supply members with a plan of systematic saving and to take care of credit problems.

COLORADO

Veta Mines Find Deep Ore in Smuggler Union

San Juan region cheered by this development, and other operators may be induced to consider deeper prospecting—Miners fight threatened tariff reductions on lead and zinc ores

▶ Veta Mines, Inc., through the expenditure of some $100,000 and diamond drilling in the Pennsylvania tunnel of the Smuggler-Union group, has proved a theory of geologists that larger bodies of ore would be found at greater depths in the San Juan region. New bodies of richer ore were picked up when the Smuggler vein was encountered on the sixteenth level, which is 125 ft. below the highest point in the Pennsylvania tunnel, which tunnel is 1,000 ft. below the bottom of the Tom Boy and Black Bear mines. Veta Mines sank a shaft 325 ft. deep about 1½ miles in from the mouth of the tunnel. From this shaft a 200-ft. crosscut was run to pick up the Smuggler vein, which previously had been located through diamond drilling. To the north the drift has reached a distance of nearly 250 ft., where it is in excess of 6 ft. in width. To the south the drift has been run nearly 50 ft., with a rapid widening of the vein. The vein is better in value than the Pennsylvania and somewhat wider. This new discovery will have much value on the Tom Boy, Cimarron, Japan Flora, and Liberty Bell, at Telluride, and the Camp Bird, Revenue, and Atlas, over the divide at Ouray, which is but a few miles from Telluride. All of these mines are among the famous producers in the San Juan section, and undoubtedly deeper prospecting may be considered this summer. Robert H. Sayre is president of Veta Mines and Charles Glasgow is general superintendent.

▶ Robert Williams, superintendent of the Cimmaron property, in the San Juan region, recently stated that the Amparo Mining Company expects to construct a mill at the mine this summer.

▶ The Gold Hub Company reports the strike of its Uncle Sam vein in the Yukon Tunnel, at approximately 1,800 ft. below cropping. It is too early to predict the full size of this vein, but sections so far opened show good mineralization.

▶ Capital Prize mine, at Georgetown, recently encountered good ore. Under the direction of Mr. Connor the company is carrying on the plan of development where the Platte Construction Company left off two years ago.

▶ Western mining men have started a movement against the Smoot-Hawley law, which gives the President the right to regulate tariff duties up to 50 per cent, up or down. Any reduction of tariff duties on lead or zinc will greatly curtail mining operations in this State. They are also protesting the reduction of duties on fluorspar, tungsten, and feldspar. A healthy mining industry is not only desirable but essential to the welfare of Colorado. Metalliferous mining in the State is largely confined to the production of complex ores, most of which contain lead and zinc. These activities, in turn, affect Colorado mine production.

▶ Zenda Gold Mining Company, at Leadville, has consummated a transaction involving the sale of approximately half of the company's property. J. L. Hickson, an official of the company, stated recently that new developments of the company will enhance the potential value of the Zenda holdings. The Bryant flotation mill, at the portal of the tunnel, affords opportunity to mine and mill a greater tonnage this summer.

▶ The Gold Coin Mining Corporation, organized by a group of financiers and manufacturers, and headed by Walter Fischer, mining engineer, has brought in

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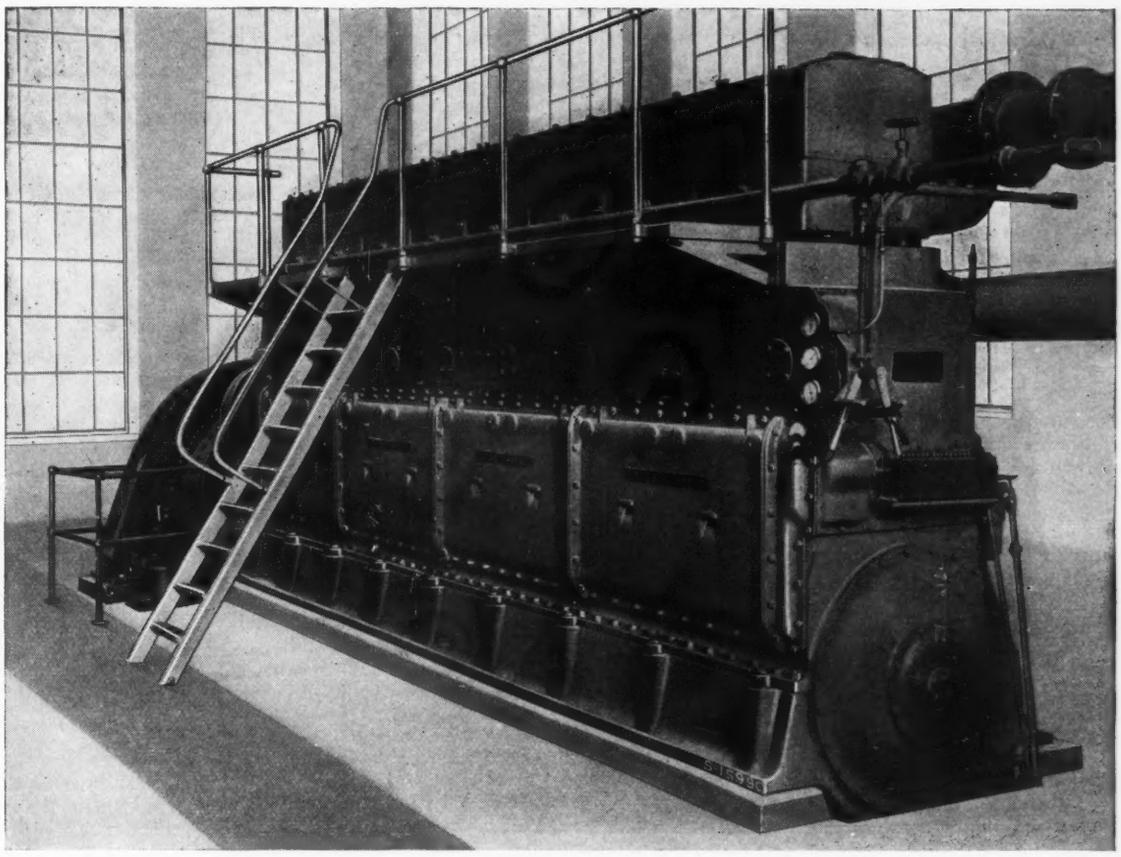

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DE8-8

▶COLORADO

new machinery for the Bertha claim, preparatory to building a cyanide mill, near Pitkin, Colo.

▶ The Ada Bell mine, at Cripple Creek, which was closed upon the death of John Tait Milliken, will be reopened with John Milliken, a son, named to the board of directors.

▶ The Mohican vein, at the 2,600-ft. level of the Ajax mine of the Golden Cycle Corporation, has been cut in the crosscut toward the New Market vein. The New Market is about 150 ft. from the Mohican. Clayton Kissell, superintendent, states that drifting will be continued for some time, and in both directions.

▶ In the Georgetown section, ore production at the Lord Byron is increasing daily; the Freeland has started developing the new vein; the Alice property of the American Smelting & Refining Company has increased mill operations; five sets of leasers are working the Donaldson; dewatering the Lamartine has been completed, and prospecting and sampling of the property is under way. To aid operators, the old, narrow trail leading to the top of Republican Mountain is being widened into a road, accessible for ore haulage.

MICHIGAN

Calumet & Hecla May Explore Seneca Mine

Plan involves five-year option—Limited copper production from Isle Royale planned in April

▶ Arrangements are under way whereby Calumet & Hecla Consolidated will take an option on the Seneca mine, in Keweenaw County. Seneca Copper Corporation bondholders have received official notice of a plan for liquidating the assets of the company and winding up Seneca litigation, subject to approval on March 2 by the United States court at Grand Rapids, Mich. The plan involves the organization of a new company by the bondholders' committee, which will bid in for all Seneca property in Michigan, and in case such new corporation acquires complete title to the property, it will give to the Calumet & Hecla Consolidated Copper Company an exclusive option to explore Seneca for a period of five years. During the existence of such option the Calumet company is to pay all taxes and keep the Seneca property free from all labor, material and other liens. An exclusive option on the part of the Calumet company to purchase the Seneca property at any time within that period for $750,000 cash also is involved. Under the agreement the Calumet company is to advance sufficient moneys to pay certain claims, including taxes, labor, and compensation claims, charges, and other expenses, but not to exceed the sum of $200,000. If the Calumet company exercises the option it is to reimburse for all such advances, taxes, development, and other expenditures on its part only out of its mining operations upon the Seneca property. There will be no deductions from the $750,000 payment.

▶ The Isle Royale mine, which is being dewatered and rehabilitated, expects to resume limited production of copper in April. A normal output of approximately 750,000 lb. per month should be reached a few months later. According to the annual report, just issued, "the mine is well opened and if anything like normal prices for copper prevail, Isle Royale should be able to operate at a profit." It is too early to determine definitely whether it will be possible to avoid calling a second assessment of 50¢ per share.

▶ Plans of the Copper District Power Company, subsidiary of the Copper Range company, for the development of additional water power on the Middle branch of the Ontonagon River in Ontonagon County, have been held up pending the outcome of a friendly court action brought by the Michigan Conservation Commission to determine the Commission's rights and authority. Preservation of the beauty of Bond and Agate falls on the river and protection of fishing in the Middle and other branches are involved. The Commisison regards its procedure as a friendly action, out of which, if a decision is returned for the State, an agreement may be reached, under which the company will be permitted to divert water sufficient for its needs without damaging the scenic value of the falls nor endangering the aquatic life in the river.

▶ With the exception of pumping operations to keep the workings free of water, there is no activity at the Ropes gold mine, north of Ishpeming. Calumet & Hecla, which has an option on the property, is employing a small crew of men.

TRI-STATE

Low Metal Prices Threaten Shutdown of Mines

Cost of supplies also reported high—Operators see about half of production eliminated if zinc tariff is lowered 50 per cent in trade agreement with United Kingdom

▶ Production in the Tri-State district has been maintained at slightly better than 7,000 tons of zinc concentrates and 1,200 tons of lead concentrates since the beginning of the year, but any prolongation of the period of present low prices will force many of the smaller operators to shut down unless the cost of supplies can be substantially reduced. Wages have been maintained at the same level as the beginning of the year, but are due for a reduction if the price of zinc concentrates drops below the present quotation of $30 per ton.

▶ All local operators are much concerned over the possible reduction in zinc and lead tariffs suggested in the reciprocal trade agreements with Canada and Great Britain. A 50 per cent reduction in the present zinc tariff would cut zinc concentrate prices in the Tri-State district $5.35 per ton. A $5 reduction in zinc concentrate prices at this time would eliminate close to half of the present production, for few of the mining companies have substantial surpluses upon which to draw to tide them over a period of operating losses.

▶ The R.H.&G. Mining Company, at Waco, Mo., has reconditioned its tailings re-treatment mill to treat mine ore and placed it in operation early in February. Ore from the Acme and Barnsdall No. 3 leases, which have recently been dewatered, will be treated at the mill. Cleve Craig, of Baxter Springs, Kan., is mill superintendent.

▶ Commerce Mining & Royalty Company reopened its Chubb mine, in Treece, Kan., the latter part of February. The ore will be trammed underground and hoisted at the mill shaft of the Wilbur mine of the same company, which adjoins it on the west. It will be milled over the Wilbur mill on the night shift. There will be no substantial increase in production, for part of the crew from the Wilbur mine will be moved to the Chubb, and production from the Wilbur mine will be reduced accordingly.

▶ Development work continues on scattered properties in the old camps of Missouri, but practically all the ore will be treated over small custom mills.

▶ The total number of mills operating in the district remains about the same, 40 to 45, but each week witnesses a few mills shutting down and others starting up, only to shut down a few weeks later.

MEXICO

Oil Producers Lose in Wage Controversy

Decision by Supreme Court against oil concerns may have far-reaching influence on workers' demands in the mining industry also—Cananea Consolidated Copper faced with strike threat

▶ On March 1 the Supreme Court of Mexico ruled against seventeen oil producers in their wage controversy, which means an obligatory increase by one-third of the wages of 18,000 workers. Many observers believe that this measure is the first of others that may follow to make other large United States and British organizations such as mining companies leave a greater part of their income in Mexico. Many believe labor unions will interpret the decision as an opening to force their demands for blanket labor contracts with the large mining companies. Fortunately, labor trouble in the mining industry is not much to the fore at present. Copper companies are feeling the pinch of depressed market conditions, and some operators have staved off strikes by granting the miners most of what they demanded. It is indicated that mining production in 1937 was much higher than in 1936. American government buying of Mexican silver has helped mining to a certain

extent. Mine workers in the State of Chihuahua lost about 784,000 pesos in wages because of the general electricians' strike in their State. Mining companies affected were spared this cost by a clause in collective labor contracts that absolves them from paying wages during shutdowns caused by failure of electric power.

▶ Cananea Consolidated Copper has a new labor worry. Workers have served notice of a strike on April 15 unless the company agrees to make a new contract which allows a minimum daily wage of 6 pesos (some $1.67) 9.50 pesos ($2.64) a day for foremen, free houses, light and water.

▶ Properties of Dos Estrellas Mining at El Oro, State of Mexico, and Tlalpujahua, in Michoacan, will be run on a cooperative basis for eight months if the national miners' union can bring into line some employees who still want to work for a straight salary. Two company guards, a soldier and Bulmaro Franco, cashier, were killed and five of the firm's employees were wounded when 75 bandits recently robbed a truck of Dos Estrellas Mining of 30,000 pesos (some $8,000), payroll for 4,000 miners near El Oro, State of Mexico.

▶ Lane Rincon Mines, El Rincon, State of Mexico, warded off a strike by allowing its workers daily salary increases of 60 centavos (17c.) for underground men and 50 centavos (14c.) for surface workers.

▶ Cia. Minera de San Carlos, San Carlos Municipality, Chihuahua, has found valuable deposits that assure early resumption of full work, according to the national miners' union, which has been asked to supply extra crews for conditioning the mines and working the new deposits. The company plans to install a large flotation plant. It is to put in more and modern machinery.

▶ There is talk of the properties leased by Cia. de Inversiones del Oro, S. A., at La Noria de San Pantelon, Zacatecas, being taken over by its 1,200 employees to run on a cooperative basis, as the company is not inclined to renew the lease which expired March 5.

▶ Mining is active in Zacatecas, particularly in the Zaragoza region, where fifty properties are in steady operation, President Lazaro Cardenas has been informed. The Zacatecas government is operating a metal-treatment plant in Zacatecas City for small-scale miners.

▶ Asarco has petitioned the Federal Government for authorization to suspend work at its El Pilar properties, Puebla. The company contends that operations there are unprofitable. Four hundred employees would be affected by the action.

▶ Guanajuato Consolidated Mining & Milling, and Cia. Minera de Guadalupe, S. A., in the Guanajuato City sector, smoothed out labor troubles by making contracts, good for two years, which grant such privileges as a seven-hour day for miners, a 50 per cent wage raise for surface men, double pay for legal holidays work, full salary for professional illness and half pay for non-professional sickness disability for fifty days each, recognition of rheumatism as a professional disease, 700 pesos (about $194) indemnification plus 45 pesos ($12.55) funeral expenses for each death, creation of a savings fund to which each workers will contribute 5 per cent of his weekly salary, medicines and medical attention to the value of 150 pesos ($41.70) for workers' folk, and transportation and expenses for employees' delegates to conventions of the national miners' union.

▶ Cia. Minera del Boleo, S. A., a French firm operating copper mines at Santa Rosalia, Lower California, of which Louis Mager is general manager, has asked the Federal Government for sanction to reduce salaries by 16 per cent. The company asserts that this reduction is necessary because of low copper prices.

CANADA

Japanese Get Vancouver Island Copper Mine

Development program under way—Pacific Nickel Mine, Ltd., will operate nickel mine at Choate, B. C.

▶ Japanese interests have acquired the old Tidewater copper mine, on Sidney Inlet, Vancouver Island, and a crew of about 30 white men is engaged in development work. The property was operated almost continuously from 1916 to 1923, and in the latter year 40,000 tons of ore was milled, averaging from 2 to 2.6 per cent copper.

▶ B. C. Nickel Mines, Ltd., is being dissolved and a new company, Pacific Nickel Mines, Ltd., will acquire and operate the mine at Choate, B. C. It is expected that a 250-ton concentrating plant will be built as soon as a contract can be concluded for the sale of the product in Japan. Last summer extensive research was undertaken by Japanese interests to evolve a satisfactory process for concentrate treatment.

▶ The Pioneer gold mine, already the deepest in British Columbia, is to be developed to a further depth of 375 ft. in the spring, according to Dr. H. T. James, managing director. Three more levels will be opened from an internal shaft to be sunk from the 26th level, which is 3,100 ft. from the surface.

▶ Hedley Mascot Gold Mines earned $810,822 from production in 1937, and a net profit of $320,450, equivalent to 14.6c. per share. During 1937 costs were reduced and mill recoveries improved, to the extent of $1.30 per ton, according to the managing director, R. H. Stewart.

▶ At the Hedley Amalgamated mine, what is described by the manager, W. G. Norrie-Loewenthal, as the most promising showing yet found is being developed at the second level. Before this ore was encountered the company acquired options on the Daylight gold

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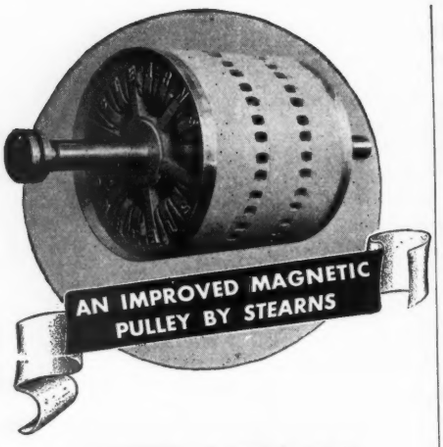

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▶CANADA

mine, near Nelson, and an interest in Utica Mines, Ltd., operating a silver-lead mine in the Slocan district. Good results are being obtained at both properties.

▶ Production at the rate of 100 tons a day is now proceeding regularly at the Durango mine, near Ymir, and the 5-mile aërial tramway is functioning satisfactorily, according to the manager, A. W. Davis. At the Ymir Yankee Girl, a winze is being sunk from the 1,500 level.

▶ The Reno mine, situated near Salmo, is being deepened from the 11th to the 12th level, and it is reported the width and grade of the ore are maintained.

▶ A fissure believed to be the "A" vein was encountered recently at the Kootenay Belle mine on the 4th level, 314 ft. below No. 3 level. In 80 ft. of drifting the vein has widened from a few inches to 3 ft. and it is expected the ore section will soon be reached. Vere McDowall is manager.

▶ At the Gold Belt, the "8,000" vein was cut recently at the 2,100 level, and ore is now being developed in the west drift. The crosscut meanwhile is being extended towards the "8,200" vein. Good lengths of ore were opened in both veins at the 1,850 level, and if the ore persists downward, as expected, a mill of 100 or 150 tons' daily capacity will probably be constructed this spring. The operation is financed by North American Mines Corporation, of Boston. Grattan Lynch is in charge.

▶ A new orebody has been found southeast of the Monarch workings at the Base Metals Mining Corporation's property near Field. The length indicated to date is 255 ft., and it is as wide as 60 ft. in places. Grade is reported to be 8 per cent lead and 20 per cent zinc. The 300-ton mill has been reconditioned for operation when metal prices improve.

▶ The shaft at St. Eugene Extension, a former large producer near Moyie, has been dewatered, and it is planned to commence exploration by diamond drilling immedately. S. Saxton is manager.

▶ Operations at the Britannia mine, the largest copper producer in British Columbia, were maintained throughout 1937 at normal plant capacity of 6,000 tons a day. An important orebody was disclosed and partly developed in the upper levels, copper values in which were about average and gold values somewhat higher. The 4,100, or main haulage, level was extended to 13,560 ft. from the portal, and upraises to the 2.700 level passed into the continuation of the orebody developed at upper levels. Diamond drilling at this level also disclosed a new lens of ore of undetermined size.

▶ The hope that the Zeballos area, on the west coast of Vancouver Island, may prove to be a gold-producing region of importance was given further substantiation recently by the development of a good oreshoot at a depth of more than 500 ft. at the Goldfield mine, and the opening of commercial values across a width of 20 ft. or more at the North Star. A 50-ton mill is to be built at the Goldfield as soon as weather conditions permit. Both the Goldfield and North Star properties are owned by Spud Valley Gold Mines, Ltd., of which P. W. Racey is engineer in charge. It is proposed that ore from the North Star be transported by aërial tramway across Gold Creek to the Goldfield property, through No. 4 tunnel, and down the opposite side of the mountain by a second aërial tramline to the mill.

▶ Metals to the value of more than $41,000,000 were produced by the Consolidated Mining & Smelting Company of Canada, Ltd., in 1937, exceeding the total for the preceding year by 39 per cent. The preliminary figure for 1937 does not include the bismuth, sulphur, sulphuric acid, and fertilizer products produced. New records were established, 413,000,000 lb. of lead and 285,200,000 lb. of zinc being recovered. Concentrate produced at the Sullivan mine and treated in the Trail smelter amounted to 514,096 tons, compared with 473,508 tons in 1936, and there were also substantial increases in the quantity of customs ore and concentrates received.

▶ A major concentration of gold that may rival anything yet discovered in Canada is undergoing intensive exploration at the southeast end of the Little Long Lac field. Hard Rock Gold Mines started the development with a series of three drill holes along the new north ore zone. MacLeod-Cockshutt Mines, adjoining Hard Rock on the east, and Little Long Lac Gold Mines, on the north, drilled a flat drill hole from the 500-ft. level at a point 200 ft. from the Hard Rock boundary, and intersected good ore 58.3 ft. wide from footage 744 to 841. The area being explored lies in an iron formation parallel to underground workings on the two properties and about 1,000 ft. to the north. Iron zones have been traced west from the Little Long Lac field all the way to the Beardmore area, a 50-mile zone of favorable geology where renewed prospecting efforts are expected to be concentrated this year. Joseph Errington, president of MacLeod-Cockshutt, has announced that the new 300-ton mill will begin operating early in March.

▶ H. S. Denny, president of Lapa Cadillac Gold Mines, estimates working costs of $4.12 per ton for the mill of 250 tons' capacity which is to be ready in August. Tonnage can be doubled by the addition of a tube mill and an auxiliary plant. Electric power will be available at the mine in March. Estimates of probable ore total 166,000 tons having an average gold content of $8 per ton. Resident engineer is Denison Denny.

▶ O'Brien Gold Mines, main operation in the Cadillac camp, northwestern Quebec, has discovered more high grade. The newest development took place on the 13th and deepest level, at a depth of 1,514 ft., 180 ft. to the east of the shaft. The grade is said to average better than 2 oz. to the ton. The location at depth and to the east of the shaft is regarded as important in view of the western location of the high-grade shoot opened up between the fifth

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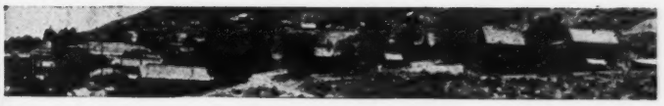

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▶CANADA

and tenth levels. To explore the occurrence at depth, shaft sinking will be continued to open up five more levels. A subsidiary of O'Brien, Cline Lake Gold Mines, is building a 200-ton mill which is due to start production this summer. Harry E. Sparks is mine manager at O'Brien and A. H. Hinton the mine superintendent at Cline. J. G. Dickenson is vice-president and general manager of both operations.

CANADA'S COPPER OUTPUT

COPPER PRODUCTION in Canada during 1937 totaled 529,773,738 lb., which compares with 421,027,732 lb. in 1936 and 418,997,700 lb. in 1935. Production last year was the highest in volume on record. Monthly production figures for 1937 (subject to revision) and 1936, according to the Dominion Bureau of Statistics, in pounds:

	1936	1937
January	34,303,820	37,282,247
February	32,917,202	38,[illegible]5,569
March	36,493,444	41,[illegible]3,786
April	35,500,956	41,[illegible],288
May	35,168,740	41,[illegible]1,784
June	31,119,359	42,049,292
July	28,693,176	41,710,830
August	35,438,299	44,583,629
September	36,132,454	48,045,881
October	34,644,498	51,853,071
November	37,007,475	50,735,281
December	43,608,309	49,240,080
Year	421,027,732	529,773,738

CORRECTION—In the chart of metal prices and world production of major non-ferrous metals, mailed with the February issue, as well as in the table on page 39 of the same number, Canada's output of copper for 1935 should have read 208,224 tons. The total on world's production for that year was correctly stated at 1,608,857 tons.

▶Hollinger Consolidated Gold Mines, issuing the 27th annual report, is shown as ranking first among Canadian gold producers on several counts, including bullion output, number of employees, length of life, and dividends paid. Since 1912, the mine has disbursed $88,488,400 in profits to shareholders. Value of ore reserves at the end of 1937 stands at $49,799,926, which is only slightly less than it was ten years ago. In 28 years of production, the highest annual recovery was recorded in 1925, at $15,749,149. Last year's gold recovery was valued at $14,877 897, which is higher than in 1935 and 1936. President Jules R. Timmins, in reviewing the year's operations, calls attention to the average value of ore reserves at the end of 1937, $11.61 as compared with $11.90 the year previous. General Manager John Knox reports that 38.3 per cent of the ore treated in 1937 came from above the 800-ft. horizon. No ore estimates have yet been made of reserves below the 3,950-ft. level, although development work in this area is well advanced. Cleaner mining and less waste resulted in increased recoveries during the year, the grade averaging 8.99. The new shaft has reached a depth of 1,100 ft. and is continuing down another 750 ft. to connect with a raise above the 2000-ft. level. Total operating costs averaged $4.84 per ton. The mill averaged 4,762 tons daily. Tailing loss was 34c. a ton.

NORWAY

Mining Industry Has Prosperous Year

Value of metal output reaches new high during 1937—Country has excess of copper, zinc, pyrites, and other metals, which are exported

▶Last year was the most prosperous for the Norwegian mining industry. Both as to quantity and value of production 1937 surpassed any previous year, as shown by the following table:

Metal, Concentrates in Metric Tons

	Pyrites	Copper	Iron	Nickel
1913	441,291	70,349	544,686	49,990
1930	730,951	25,045	722,423	29,084
1931	359,951	14,604	574,877	15,242
1932	727,020	18,376	373,907	23,363
1933	865,576	22,093	473,863	23,614
1934	960,898	23,374	567,414	29,213
1935	893,513	25,821	765,152	31,471
1936	1,031,825	27,229	846,809	33,311
1937	1,050,000	26,800	1,050,000	20,000

	Zinc and Lead	Molybdenite	Ilmenite	Graphite
1913	897	12	.....	300
1930	11,462	284	7,600	672
1931	14,871	223	5,000	2,086
1932	17,663	329	13,481	2,672
1933	18,789	414	23,213	2,086
1934	13,238	244	26,306	2,495
1935	12,919	647	37,984	2,663
1936	15,822	703	67,194	3,600
1937	17,200	600	67,500	3,800

The figures of 1937 are estimates based on preliminary data from the mines; others are official statistics. Total ore mined in 1937 was 2,250 000 metric tons and estimated value of metals recovered was about 50,000,000 krone (1 krone = $0.4537). Value of 1936 output was 39,891,000.

Cuprous and non-cuprous pyrite is produced by eleven companies. About 65 per cent of production is cuprous pyrite containing 1.3 to 2.5 per cent copper; 20 per cent is below 0.6 per cent copper and 15 per cent is decoppered flotation pyrite. The largest producer was Orkla Grube, whose output in 1937 was 560,000 tons of cuprous pyrite, of which more than half was treated in its Orkla metal plant, where 105,000 tons of sulphur and 15,000 tons of copper matte were produced. The remainder of the Norwegian pyrite is mostly exported. exported.

Copper concentrates containing from 18 to 25 per cent copper are produced by seven of the pyrite mining companies. The concentrates at the Sulitjelma and Roros mines were smelted and refined, and yielded about 4,800 metric tons copper in 1937. Concentrates from other mines are exported. Total yield of metallic copper from smelted concen-

trates, exported concentrates, matte, and cuprous pyrite was about 17,000 metric tons in 1937.

Iron ore production has been prosperous in 1937 as never before, eight mining concerns partaking. Foremost comes A/S Sydvaranger, which, from its Kirkenes mines, produced about 725,000 tons of concentrates, briquets, and high-grade ore. Three new porducers were registered in 1937: Dunderland Iron Ore Company, producing about 5,000 tons ore per month since September; Middavarre mines, in Kvenangen, yielding 5,000 tons of high-grade ore; and Orkla Metal A/B, producing 45,000 tons iron slag for export from its copper matte plant. The combined pyrite, copper-ore, and iron-ore production represents about 85 per cent of the value of the country's total mineral production in 1937.

Zinc is produced by five concerns, principally as a byproduct from the copper-pyrite flotation plants. Zinc blende and galena are main products only at the Mofjellet mine, in Rana.

Nickel ore is produced by the Raffineringsverket A/S from its two mines and smelted at its plant. Output in 1937 was 900 tons nickel and 640 tons copper.

Molybdenite comes almost exclusively from the Knaben mines, where a high-grade flotation concentrate is made.

Ilemenite concentrate is produced by A/S Titania at Dalane, giving some 17,000 tons of magnetite concentrate as a byproduct.

Graded graphite concentrates are produced by two mines in the north of Norway. Silver ore yielding 8,000 kg. of silver was produced at the State mines at Kongsberg. The outlook of the Norwegian mining industry is bright.

YUGOSLAVIA

Gold Production Soon From Trosnyk Mines

New plant nears completion — Trepca Mines, Ltd., developing ore on new deeper level

▶ Trosnyk Mines, Yugoslavia, is reported to have nearly completed a new plant for the treatment of 100 tons of gold ore daily. From this output it is estimated 25 to 30 kg. of gold will be produced monthly. This company was registered in January, 1936. It acquired Yugoslav Goldfields, including concessions and rights near Sarajevo. After 1,200,000 five-shilling shares of the £500,000 capital had been issued (740,000 for cash), 680,000 shares were offered publicly; but due to adverse criticisms of ore reserve statements in the prospectus, the issuing house, British Pacific Trust, returned all subscriptions and undertook to provide the whole of the capital required for the company's operations. It is now announced that arrangements have been made for all calls on the capital of Trosnyk Mines to be paid. The financial management is now in the hands of Sydney List, who is managing director of Allied Banking Corporation of Great Britain, which has established a branch in Yugoslavia. C. F. Lumb is chairman of Trosnyk Mines.

▶ Net earnings of Trepca Mines, Ltd., before depreciation and taxation, for the December quarter were £94,219, against £180,264 in the September quarter. Lower prices for zinc and lead accounted for the decrease. In January production was 6,004 metric tons of 79.69 per cent lead concentrates averaging 28 oz. of silver per ton, and 7,059 tons of 49.69 per cent zinc concentrates. A new, deep level has been reached at 435 meters' altitude, and development started.

AUSTRALIA

Satisfactory Operations At Big Bell Mine

First two months-mill run devoted to treating low-grade ore—Australia's largest gold dredge starts operating

▶ Big Bell Mines, Ltd., which is controlled by Premier Gold, an A.S.&R. subsidiary, treated 54,747 tons of ore from its property near Cue, W. A., in the first two months milling to the end of November. Gold production was 5,430 oz., or approximatelly 2 dwt. per ton, but this does not reflect average production, due to plant absorption and to the intentional treatment of low-grade ore. Dale Pitt is general manager.

▶ The dredge of Wellington Alluvials has just begun operations on the company's leases at Wellington, Macquarie River, N. S. W. The dredge, the largest in Australia, has a capacity of 250,000 to 300,000 cu.yd. monthly. The bucket band has 110 manganese steel buckets of 14-cu.ft. capacity and the dredge is capable of digging from a depth of 75 ft. below water level. Gold recovery is by jigs, Bendelari jigs being used in the primary circuit and Pan-American Crangle and Bulolo type Placer as reconcentrators. Resoiling equipment is provided. All equipment is electrically driven, power being obtained from the Government station at Lithgow, 110 miles distant. Installed horsepower totals 1,500. The property contains over 60,000,000 cu.yd. of wash payable at present gold prices, and two more dredges may soon be installed.

▶ Completion of the plant of Victoria Gold Dredging, Newstead, Victoria, is now scheduled for mid-May. The dredge is expected to dig 175,000 cu.yd. monthly of wash averaging 3.6 grams per cu.yd.

▶ Anglo-Queensland Mining, Pty., Ltd., a subsidiary of Mount Isa, which has been testing the Howley gold mine, near Brocks Creek, Northern Australia, for eighteen months, is expected to make an early announcement of its intentions with regard to the property. The mine was extensively worked in the early days by Chinese miners, reputed production being about 250,000 oz.

▶ It is reported that Mount Morgan, Ltd., operating the Mount Morgan copper-gold mine, Queensland, is to make an issue of preference capital for the purpose of financing the erection of a smelter and the extension of its mechanical equipment program for the mine.

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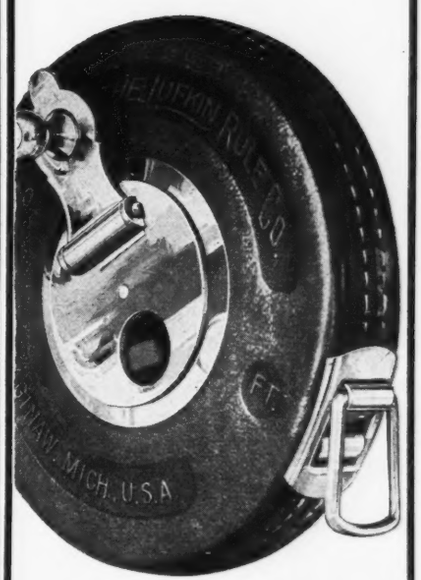

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▶AUSTRALIA

▶ Australian gold yield for the year just closed is estimated at 1,375,000 oz., of which Western Australia contributed just over 1,000,000 oz., its best yield since 1916. The total of 1,375,000 oz. showed an increase of 197,000 over that of the year 1936 and there seems every prospect that 1938 will register a further advance.

▶ H. J. C. Conolly, geologist of the Western Mining Corporation, in a report on the Wiluna mine, states his belief that there are good hopes for the recurrence at depth of lodes which do not outcrop at the surface. He has made recommendations for an extensive drilling campaign, which is to be begun at once.

▶ Extensions to the mill of Triton Gold, near Cue, W. A., designed to increase output by 50 per cent to 9,000 tons monthly, began operation on Dec. 23, 1937. Operations are proceeding satisfactorily.

▶ Production of the Bendigo (Vic.) gold field of 45,913 oz. during 1937 was the highest for many years. The leading mine during the year has been Central Nell Gwynne, which treated 20,186 tons in its 20-head battery for 5,409 oz. This company has just purchased the lease and pumping plant of the adjoining Nell Gwynne mine, a Bendigo Mines subsidiary. Other mines with good prospects are the Deborah, North Blue, and South New Moon.

▶ Producers on the Golden Mile, Kalgoorlie, generally showed increased treatment rates during 1937. Lake View & Star treated 607,420 tons of ore and re-treated 723,005 tons of tailings for a total revenue of £1,357,798 (Australian). Mine working profit was £566,891 (Australian). Great Boulder Proprietary increased its tonnage from 191,821 in 1936 to 218,224 in 1937 and is planning a gradual expansion to 300,000 yearly. The mine recently had a good development in driving north at the 2,600-ft. level, where a new lode with good values over a substantial width has been encountered.

▶ The New Cobar mine of the New Occidental Gold Mines, which went into operation on Nov. 21, raised 3,592 tons up to the Christmas shutdown on Dec. 24. The mill produced flotation concentrates containing 1,206 oz. gold and 53 tons copper.

▶ Cocks Pioneer Gold & Tin, Eldorado, Victoria, has not yet decided whether dry-handling or sluicing methods will be adopted in removing the 80 ft. of overburden which lies above the wash in the new ground recently proved by boring. In the meantime the present plant is to be moved and operations will be resumed, the overburden being sluiced off for the time being. It is planned to treat an area containing 570,000 cu.yd.

▶ Morning Star, Woods Point, Victoria, is carrying out a drilling campaign seeking ore below the present workings.

H. J. Barker, Unganda, East Africa

In the Ankole and Kabale districts of Uganda, East Africa, low-grade shallow gold placers are being worked. Pay dirt is carried in steel head pans to the sluice boxes and fine gold to 1 oz. nuggets is sometimes found

AFRICA

Rhodesian Coppers' Profit Shows Sharp Drop

Lower prices for the metal and curtailed output account for decline in last quarter —New unit of Marlu mill placed in operation in January of this year

▶ Rhokana Corporation reports an estimated profit for the six months to Dec. 31, 1937, of £1,136,000, this after debenture interest, depreciation, and development reserves, and not including the dividend received on its holdings of Mufulira Copper. Production was 23,443 long tons of blister copper and 16,241 long tons of electrolytic. The profits of the two quarters are not given separately in the report.

▶ Roan Antelope Copper Mines made a profit of £359,000 in the December quarter, this after an allowance of £50,000 for replacements and obsolescence (depreciation), with the price of standard copper averaging only £41 10s. 9d. per long ton. As gross revenue was £833,500, production, or rather sales of copper arriving in European markets during the quarter, must have been approximately 20,000 long tons. Its profit for the preceding quarter was £685,500, the price of copper having then averaged £14 per ton higher, making for the last six months of the year £1,045,500.

▶ Mufulira Copper Mines reports an estimated profit of £240,500, after charging £25,000 to depreciation but before taxation, for the quarter ended Dec. 31. This compares with £324,000 for the September quarter, when the price of copper averaged £14 higher. As its gross revenue was £600,500, sales appear to have been about 14,469 long tons of copper. This indicates that Mufulira had not yet reached its full quota allowance under the curtailment of production agreement, which is 5,200 long tons per month, or 15,600 tons per quarter. Cost of production, including depreciation and everything except taxation, appears to have been about £24 9s. per long ton of blister copper.

▶ The fourth unit of the Marlu Gold Mining Company's plant began operation at about the end of January, and is reported to be working satisfactorily. With the three units, Marlu's January profit was £46,465.

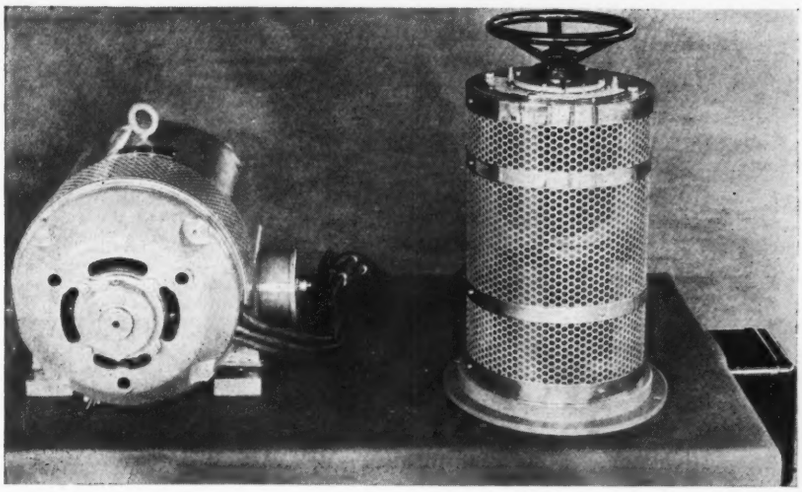
▶ Another important Gold Coast development was the addition of 758,500 tons to the proved ore reserves of Bibiani (1927), Ltd., bringing the total up to 2,807,800 tons averaging 7.8 dwt. per ton. Bibiani, partly owned by Ashanti Goldfields, increased its profit by £26,800 last year, to £108,300. A new issue of Bibiani's 4s. par shares has just been taken by shareholders at a price of £1, providing funds for plant expansion.

▶ Ashanti Goldfields' profit for the year to Sept. 30 was £956,186, against £924,694 the preceding year. Higher wages and supply prices, and the treatment of more graphitic ore, the last necessitating changes in and additions to equipment, increased costs. Dividends paid, 95 per cent, called for £950,000, the same as the year before. Ore reserves when the year ended were 1,595,113 tons averaging 19.7 dwt. per ton, an increase of 137,082 tons and a decrease of 0.3 dwt.

▶ Tanganyika Concessions, Ltd., which owns 176,649 shares of Union Minière du Haut-Katanga, practically the whole of the Benguela Railway, and has large holdings of Kentan Gold Areas, Rhodesia Katanga, and other mines and properties, plans to reconstruct and reduce its capital. The object is to write off a debit balance and to depreciate certain investments, and put the company in position for an early resumption of dividends on its preference shares.

EQUIPMENT NEWS

Shunt Motor A.C. Adjustable Speed



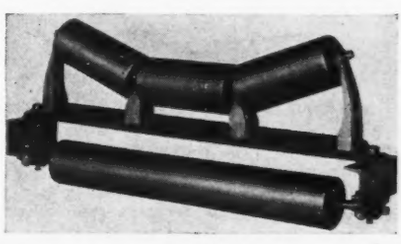
CROCKER-WHEELER Electric Manufacturing Company, Ampere, N. J., announces what is said to be an efficient alternating-current motor capable of speed regulation over a wide range and adapted to many industrial uses. Marketed under the trade name of Polyspeed Motor, it is a three-phase alternating-current adjustable-speed shunt unit. It is said to be an ingenious combination of an A.C. and D.C. motor, and of simple, rugged construction.

The motor is said to have an infinite number of speeds and can be operated at any speed desired from slightly above standstill to 1,800 r.p.m. by simply turning the rotor of the speed regulator through an angle of 180 deg. The manufacturer states it has a constant torque over the whole speed range and, in some cases, it is possible to operate the motor at increased torque at the higher speeds, making it adaptable to the driving of fans and centrifugal pumps. At speeds below synchronous speed the slip energy, which in the ordinary slip-ring induction motor is dissipated in the secondary resistance, is returned to the line through the speed regulator. At speeds above synchronous speed, a part of the energy for driving the motor is fed into the stator and part directly into the rotor. The motor is said to have available starting torques of 300 or 400 per cent.

Limitations of the motor are reported to be few. If it is to be frequently reversed during the service, the brushes must be set in a compromise position, as the brush position which gives the best motor performance in one direction of rotation is not the best position for the opposite direction. The smaller Polyspeed Motors can be started with the speed regulator set in any position and will immediately come to the corresponding speed, but large motors of this design should not be started unless the speed regulator is set near the minimum position, from which position the speed regulator should be moved slowly toward the higher speed position desired. The company states that this type of motor has not yet been made commercially in sizes larger than 7½ hp., but problems of larger motors are rapidly being solved.

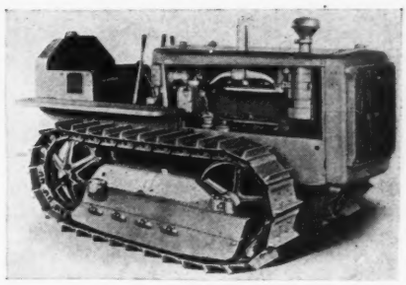
Ball-Bearing Belt Idler

A NEW INEXPENSIVE ball-bearing belt idler for carrying moderate loads of semi- and non-abrasive materials is announced by the Jeffrey Manufacturing Company, Columbus, Ohio. This idler is of the conventional three-pulley, 20 deg. troughing type, made for 14-, 16-, 18-, 20-, 24-, 30-, and 36-in. belts. Its ball bearings are of the commercial type, with a cork seal within a pressed steel labyrinth dust cap. Pulleys are of 4-in. diameter welded steel pipes with formed steel gudgeons welded in the ends. These gudgeons are said to be connected within the pulley by steel tubing which prevents the loss of grease into the pulley proper. Shafts are ¾-in. seamless tubing and are held by setscrews within machine-bored holes in the stands. As these shafts are hollow, the entire idler may be lubricated from either end through pressure fittings.



Small Diesel Tractor

CATERPILLAR TRACTOR Company, Peoria, Ill., has announced the Diesel D2, smallest of the current "Caterpillar" diesel tractor line. Ideal for the hauling of supplies, as well as working the smaller rotary scrapers, or maintaining and building mine roads, the new tractor is said to consume, under average conditions, only 1¼ gal. of fuel per hour. The new tractor has a four cylinder four-stroke cycle engine, which is said to develop 25.5 hp. at the drawbar, and 31.5 hp. at the belt. Only three engine operating adjustments are said to be made—the water pump, the valve clearance, and the fan belt. A unique feature of the Diesel D2 engine is the twin radiator. One is for cooling the water, and the other for cooling the lubricating oil, thus insuring longer life for the engine bearings. A hot-water manifold on the front side of the fuel filter housing is an interesting all-weather feature. This keeps the diesel fuel at the proper temperature, regardless of climatic or operating conditions.

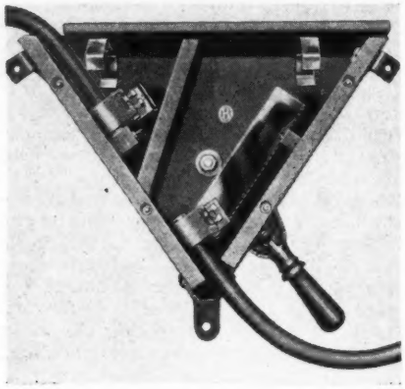


New Grinding Unit

W. W. GIBSON, 112 Market St., San Franciso, Calif., has introduced the screenless combination elliptical roll and ball mill, which is designed to crush, grind, and classify in a single pass. As built, the new combination mill consists of a crushing section in which operates a heavy elliptical roll, followed by a conventional ball-mill unit with a manganese grizzly at each end, and the classifying spiral in the discharge trunnion. It is sturdily built, alloy steels being used for the different parts, and the chief advantages claimed for the mill by the manufacturer are: (1) It is a complete milling plant in one unit, and as a consequence reduces the cost of mill construction 50 per cent and effects a power saving of more than 33 per cent; (2) the crushing compartment runs continuously without adjustment and with low metal consumption; (3) the classifier is screenless, requires no power, has no wearing parts, and takes small space; (4) a uniform product is produced at all times, increasing capacity of the grinding compartment; (5) classification can

be made from 20 mesh to minus-200 mesh by simply turning the water valve; and (6) no oil and grease can drop from the crankshaft or bearings into the ore bin to foul the mercury and amalgam, as with crushers. The combination mill is built in 12-, 25-, 50-, and 100-ton sizes handling 4-, 6-, and 8-in. mine-run ore.

Safety Feeder Switch



A NEW, INEXPENSIVE, low-capacity feeder safety switch has been designed by the Ohio Brass Company, Mansfield, Ohio, to displace open-type knife-switch installations in mines and industrial plants.

The switch is of the quick-make, quick-break type, for 250-600 volts and is furnished in 300- and 400-amp. sizes. Enclosed in a fireproof case, it affords a safe means of disconnecting the circuit under load without danger to the operator or damage to the switch. A heavy rubber handle provides further protection.

New Pumps

GOULDS PUMPS, Inc., Seneca Falls, N. Y., announces for 1938 a complete new line of single-stage, side-suction, ball-bearing centrifugal pumps. There are eighteen sizes with capacities from 5 to 1,800 g.p.m. against heads up to 110 ft. for flat or V-belt or direct-motor drive. The most modern hydraulic design is said to be embodied in casings, impellers, and stuffing boxes. Structural strength and amply proportioned parts are said to be supplied without excess weight.

Heavy-Duty 1¼-Yd. Excavator

HARNISCHFEGER Corporation, 4400 West National Ave., Milwaukee, Wis., presents to the earth-moving field the new P&H Model 555, which the company features as the fastest excavator in the 1¼-yd. class. Presented as a fully convertible machine with positive chain crowd and tractor-type crawlers, the new 555 is said to give instant response to controls, effortlessly bites into the toughest banks, has snap in starting, stopping and reversing and turning on a small area under full loads. The excavator is said to be made of new alloy steel that is all welded from crawler frames to dipper teeth.

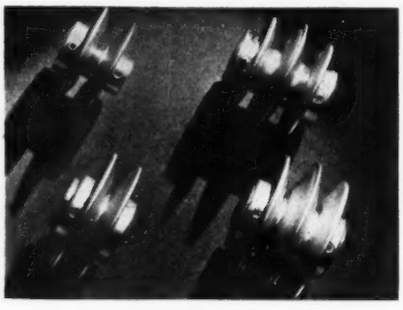
Advantages listed by the manufacturer of the P&H 555 are—special compensator springs to provide uniform track tension and take up all slack in the crawler track; shock-absorbing chain drive to transmit power to crawlers smoothly and dependably under all conditions; revolving upper swinging on large roller bearing for even weight distribution; hook rollers to protect center pin from all tipping strains.

A double-safety boom hoist is said to make it impossible to drop the boom suddenly and cause damage to workmen.

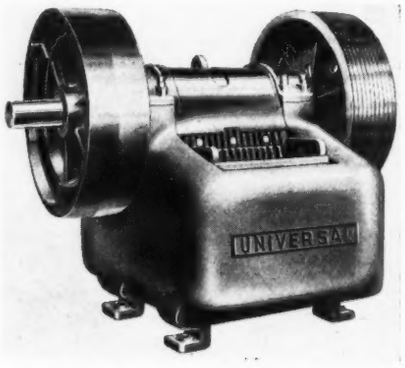
With gas or diesel engine power, the P&H 555 is said to have ample power with low fuel maintenance cost for years of trouble-free service. Other features are: Wide extra-capacity band brakes, vertical hand-steering wheel and P&H patented cam gear steering device, antifriction bearings, two-speed transmission, and centralized lubricating stations.

Adjustable Pitch Diameter Sheaves

ALLIS-CHALMERS Manufacturing Company, Milwaukee, Wisconsin, announces a new series of two-groove adjustable pitch diameter, texsteel sheaves



for a speed variation up to 33 per cent on any driven unit. This type of sheave is said to provide a sturdy, inexpensive, easily adjusted, variable-speed drive for applications where the required load does not exceed 3 hp. They are now available in three sizes of 2 to 3 in., 2.5 to 3.5 in., and 3.5 to 4 in. variations respectively. The pitch diameters on these sheaves are said to be easily changed in a moment, by stopping the motor, relieving the belt tension, releasing the Allen head locking screw and turning the adjustable plate in or out to the desired pitch diameter. These sheaves are furnished complete with a wrench for the Allen head-locking screw and a circular calculator showing directly the speeds of the driven unit.



Streamlining the jaw crusher is announced by the Universal Crusher Company, Cedar Rapids, Iowa. The company's new 10x16-in. crusher shown above is said to possess greater strength. Weight saving is said to be approximately 20 per cent over conventional types of crushers

BULLETINS

Drill Steel. SKF Steels, Inc., 369 Lexington Ave., New York, N. Y. An attractive bulletin presenting practical data for for both users and buyers of rock drill steel. Pp. 44.

Pump. Fairbanks-Morse & Co., 900 South Wabash Ave., Chicago, Ill. Bulletin APB 231.2 describes a two-stage pump that is built together with the motor. Pp. 4. **Diesel Generating Set.** Bulletin 3600-A2 describes and illustrates construction and application of the Model 136-A diesel generating set. Pp. 15.

Pipe Repair Handbook. M. B. Skinner Co., South Bend, Ind. A small booklet describing emergency pipe repair clamp and other products, made by the manufacturer to repair pipes. Pp. 12.

Diesel Locomotive. The Ruth Co., Denver, Colo. Bulletin describes exhaust gas conditioning of the Ruth underground diesel locomotive. Pp. 7.

Industrial Heating Units. Dravo Corporation, Pittsburgh, Pa. Bulletin 30-C-14 describes and illustrates direct-fired unit heaters for use in industrial plants. Pp. 20.

Equipment Folder. Denver Equipment Co., Denver, Colo. Bulletin 3700 describes the manufacturer's low-head thickeners, diaphragm pumps, mineral jigs, agitators, and flotation units. Pp. 4. Bulletin 3726 lists specifications of the company's Blake-type crushers. Pp. 2. Bulletin 3709 gives operation data on the Denver Timber Framer. Pp. 2. Bulletin 3707-B describes the Denver Portable Mill. Pp. 4.

Rock Drills. Independent Pneumatic Tool Co., 600 West Jackson Boulevard, Chicago, Ill. Catalog 41 contains illustrations and specifications of the company's Thor rock drills, paving breakers, clay diggers, and related tools. Pp. 60.

Rock Bit Grinder. J. G. Blount Co., Everett, Mass. Folder describes the manufacturer's four models of rock-bit grinders.

Mine Cars. C. S. Card Iron Works Co., Denver, Colo. Catalog 30 describes the various types of mine cars made by the manufacturer. Pp. 8.

Pyrometers. Brown Instrument Co., Wayne & Roberts Ave., Philadelphia, Pa. Catalog 1102 describes the company's line of potentiometers and pyrometers for indicating, recording and controlling purposes. Pp. 48.

Wire Rope Clips. American Hoist & Derrick Co., St. Paul, Minn. Catalog CCB-2 illustrates various uses for the "Crosby" wire rope clips and shows proper method of use. Pp. 19.

Mine Locomotive Headlights. General Electric Co., Schenectady, N. Y. GEA-2640 folder describes features of incandescent headlights for mine locomotives. GEA-961B lists advantages of helical resistor units for locomotive cable-reel motors. GEA-2641 describes features of an improved axle bearing for mine and haulage locomotive motors. GEA-2625 describes a brakescrew locking device for mine and haulage locomotives. GEA-2643 illustrates roller-bearing journal boxes. GEA-1285A gives features of a track-type limit switch for limiting all types of linear motion. GEA-1569A mentions features of a thrustor operated valve for pipe sizes of 1 to 10 in.

Operating Data. Hardinge Co., Inc., York, Pa. Bulletin 41 contains figures obtained from a wide range of average operations and lists data on equipment used for grinding, classifying, thickening, weighing, feeding, and drying. Pp. 12.

Jaw Crushers. Universal Crusher Co., 625 C Ave. Northwest, Cedar Rapids, Iowa. Bulletin 100 describes bronze-bearing jaw crushers. Bulletin 200 covers the company's roller-bearing jaw crushers. Bulletin 300 illustrates Universal roll crushers. Folder 19 describes the manufacturer's 30-Q portable plants.

Drilling Rig. Sullivan Machinery Co., Claremont, N. H. Bulletin 87-B describes, and illustrates, the company's new UW-161 featherweight drill rig. Pp. 4.

Industrial Lighting. Westinghouse Electric & Manufacturing Co., Cleveland, Ohio. Bulletin F-8408, describes rigid construc-

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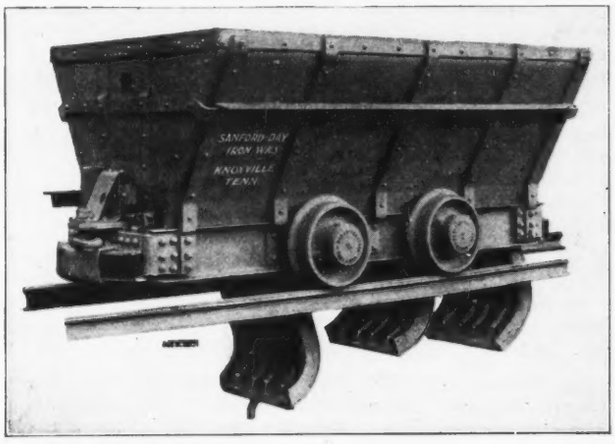

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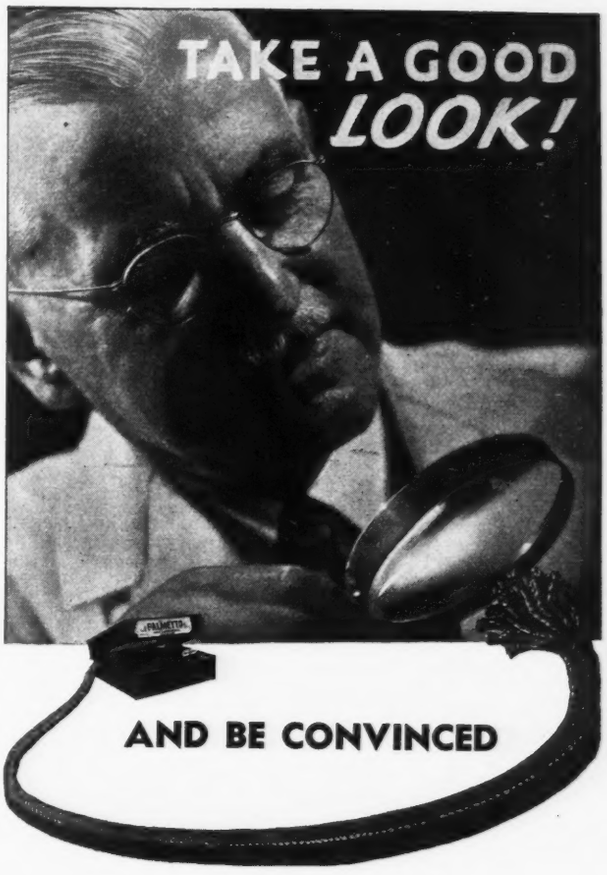

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tion and application of the Millite lighting unit for industrial plants. Pp. 4.

Caterpillar Diesel Engines. Caterpillar Tractor Co., Peoria, Ill. Form 4253 illustrates and describes seven sizes of the manufacturer's diesel engines. Charts illustrate the maximum and rated performance of these seven engines. Pp. 30.

Rock Drills. Ingersoll-Rand Co., Phillipsburg, N. J. Catalog 4201 is a well-illustrated and informative book on the manufacturer's rock drills and associated equipment. Eight pages are devoted to useful data as metric conversion tables, friction of air in pipe and hose, horsepowers required to compress given quantities of air to specified pressures, and compressor capacities required to operate from one to seventy drills. Pp. 80.

High-Strength Alloys. Haynes Stellite Co., 205 East 42d St., New York, N. Y. This booklet presents complete information on the four Hastelloy alloys, such as their chemical and physical properties, methods of fabrication, and machining, and welding, and penetration rates are tabulated for a number of the highly corrosive acids. Pp. 36.

Welding Control. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Bulletin 2123 points out suggestions by the manufacturer to increase profits with improved welding quality by resistance welding with ignition split-second control. Pp. 9.

Ore and Gravel Washing Equipment. Allis-Chalmer Mfg. Co., Milwaukee, Wis. Bulletin 1471-A describes and illustrates blade mills, drum-type scrubbers, screw washers, and log washers. Pp. 16.

Metal-Sprayed Surfaces in Relation to Lubrication. Metallizing Engineering Co., Inc., 44 Whitehall St., New York, N. Y. Booklet is a reprint of a paper presenting investigation of behavior of metal-sprayed surfaces as journal and bearing surfaces. Pp. 15.

Neoprene Notebook. E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Vol. I. No. I is the first issue for loose-leaf filing, presenting practical facts about Neoprene for engineers. Pp. 4.

Wire Cloth. Newark Wire Cloth Co., Newark, N. J. Catalog 32, pocket size, describes and illustrates various sizes and types of woven-wire screens, metallic filter cloth, testing sieves, and foundry riddles, and contains useful information about wire cloth and screens. Pp. 104.

Variable-Speed Reducer. Stephens-Adamson Mfg. Co., Aurora, Ill. Catalog 68 describes the manufacturer's four types of J.F.S. variable-speed reducers.

Rigger's Handbook. Broderick S. Bascom Rope Co., 4203 North Union Blvd., St. Louis, Mo. This pocket-size booklet contains handy information about wire-rope slings and fittings and directions for a splicing and socketing wire rope. Pp. 56.

Rock Crushers. Hadfields, Ltd., Hecla Works, Sheffield, England. Bulletin 408 describes and illustrates various types of jaw and gyratory crushers. Pp. 11.

Multi-Color Mineral Recording. Brown Instrument Co., Philadelphia, Pa. Folder 849 describes the company's unique device that produces colored numerical records on charts of the Brown potentiometer pyrometer recorders. Catalog 5001 describes the manufacturer's combustion-control devices. Pp. 24.

Vibrating Screens. Productive Equipment Corp., 4600 South Kedize Ave., Chicago, Ill. Booklet presents historical and operating information and data tables on controlled vibration and screen efficiency. Pp. 32.

Pilot-Plant Equipment. Patterson Foundry & Machine Co., East Liverpool, Ohio. Booklet describes pebble, ball, and tube mills, and filter presses for laboratory use. Pp. 7.

Prospector Core Drills. E. J. Longyear Co., Minneapolis, Minn. Bulletin 51 describes and illustrates features of the company's diamond-core drill for drilling to depths of 300 ft. producing 7/8-in. core. Pp. 11.

Ball Mill. Sundfelt Equipment Co., 3315 First Ave., South, Seattle, Wash. Bulletin 17 describes the manufacturer's new Airplane ball-mill unit for complete grinding, circulating, and classifying. Pp. 2.

Jaw Crushers. Smith Engineering Works, Milwaukee, Wis. Bulletin 264-D describes the Telsmith-Wheeling new 10x21-in. and 24x36-in. jaw crushers. Pp. 11.

Vibrator Screens. Diamond Iron Works, Inc., Minneapolis, Minn. Bulletin D-37-B describes the manufacturer's triple-, double-, and single-deck vibrator screens. Pp. 7.

Ventube System of Auxiliary Ventilation. E. I. du Pont de Nemours & Co., Inc., Fairfield, Conn. A well-illustrated brochure describing various uses and installation of flexible, acid-resisting fabric tubing called Ventube. It is recommended by the manufacturer for exhausting dust-laden air from around rock-drilling operations or for other auxiliary ventilation purposes underground. Several diagrams show quick and simple methods of installation in metal mines and tunnel projects. Pp. 43.

Equipment Catalog. Western Machinery Co., 760 Folsom St., San Francisco, Calif. Catalog 5M138 describes and illustrates the manufacturer's agitators, classifiers, diaphragm pumps, thickners, and ore feeders for various capacity installations. Pp. 18.

Dust-Control Equipment. Spencer Turbine Co., Hartford, Conn. Bulletin 111 illustrates the company's method employing its Drill Vac equipment for dust control on drifters, stopers, wagon drills, and jack hammers, Pp. 7.

Used Equipment. Stock List No. 144 of Equipment Corporation of America, 1150 South Washtenaw Ave., Chicago, Ill. Pp. 47.

Ball and Pebble Mills. Paul O. Abbe, Inc., Little Falls, N. J. Booklet by manufacturer is entitled "For Ultimate Economy and Results in Ball and Pebble Mill Operations." Pp. 20.

Automatic Boiler Feed-Water Regulator. Northern Equipment Co., Erie, Pa. Bulletin 409-A describes the Copes Flowmatic Regulator for feed-water control for boilers handling wide load fluctuations. Pp. 7.

INDUSTRIAL NOTES

Worthington Pump & Machinery Corporation, of Harrison, N. J., recently announced the acquisition of an interest in the Moore Steam Turbine Corporation, of Wellsville, N. Y.

Announcement was recently made of the appointment of Joseph A. Messenger, formerly of United Engineers & Constructors, Inc., as general manager of the Buell Engineering Company, Inc.

Atlas Powder Company announces that J. H. Buchanan will have charge of the new sales office of the company located in the Field Building, 135 South La Salle St., Chicago, Ill.

J. H. Mitchell-Roberts, export manager for Oliver United Filters, Inc., is now in Australia, where he will spend several months with the company's agent, Crossle & Duff, Pty., Ltd.

J. C. Farrant is making an extensive visit to mines in Eastern Europe, Egypt, Kenya, and Tanganyika in the interest of the grinding, screening, and filtering division of International Combustion, Ltd., London.

Sherwin F. Kelly has taken over sole control of Geophysical Explorations, Ltd., of Toronto, Canada, and is now president of the company. Marion Kelly is secretary-treasurer. He has resigned as an officer and director of Combined Geophysical Methods, Inc., of New York City, which company is ceasing business. Its files, technical records, and literature, and most of its equipment, have been acquired by S. F. Kelly for Geophysical Explorations, Ltd. The latter company, under his direction, will carry out geological and geophysical surveys in Canada, the United States, and elsewhere, operating from its Toronto headquarters, 330 Bay St. John D. Galloway, of Vancouver, represents the company on the Pacific Coast. L. B. Wright is vice-president of the company. Its New York address is 17 Battery Place.

Based on the theme "Metals in Industry" the Western Metal Congress and Exposition, held from March 21 to 25 in the Pan-Pacific auditorium and Biltmore Hotel, Los Angeles, is expected to attract 3,000 executives, plant operators, metallurgists, and superintendents to the Congress and many thousands to the exposition. The exposition, held in Los Angeles eight years ago, was attended by 60,000, but William H. Eisenman, secretary of the American Society for Metals, said an earnest effort will be made to eliminate the curiosity seeker and to attract only 25,000 interested men, who are definitely connected with the fabrication of industrial metals.

Among the eighteen national technical societies co-operating in the double event is the American Institute of Mining and Metallurgical Engineers. The mining session will include the following papers. "Metals Used in Production Mining Equipment," Dr. G. B. Waterhouse, professor of metallurgy, Massachusetts Institute of Technology, Cambridge. "Metals Used in the Smelting Process." Author to be announced. "Metals Used in Dredging Process." C. M. Romanowitz, sales manager, and Herbert A. Sawin, assistant sales manager, Yuba Manufacturing Company, San Francisco.

Denver Equipment Company announces a new branch office at 725 McIntyre Building, 68 South Main St., Salt Lake City, Utah, with T. S. Bailey, Jr., district manager, Ernest Blessing and J. W. Johns, Jr.

Fairbanks, Morse & Company have moved their general offices to the modernized Fairbanks-Morse Building at 600 South Michigan Ave., Chicago, Ill.

South Bend Air Products, Inc., South Bend, Ind., was recently organized to purchase and continue the ventilating equipment business formerly conducted by the Industrial Fan Division of the Bendix Products Corporation. Marshall A. Smith, Jr., is president and general manager.

The Sawtooth Company, 710 Front St., Boise, Idaho, announces that T. H. Barrett, mining engineer, of San Francisco, has joined the company's sales force.

Pioneer Engineering & Manufacturing Company, 31 Melbourne Ave., Detroit, Mich., announces the appointment of the Willis J. Stutson Company, 184 No. Wacker Drive, Chicago, Ill., as exclusive representative in the Chicago and northern Illinois district.

G. J. Hawkey, of the Cleveland Duplex Machinery Company, Inc., Penton Building, Cleveland, Ohio, has recently been appointed to handle the sale of all products of the Audubon Wire Cloth Corporation in the Cleveland district.

Rudolf P. Jugel, of Denver, Colo., president of the American Ball Mill Company, announces publicly that he has legally changed his name and will henceforth be known as Richard William Marland.

Drilling With Detachable Bits—IV

IN THE THREE preceding installments of this article, the practice in vogue at various mines in the Western United States with respect to use of standard sharpened drill steel and detachable bits has been dealt with. On this page and the following one the description of the work at Western Mine No. 3, begun in the February issue, is concluded and some other properties are taken up.

Western Mine No. 3
Regular Steel
(Continued)

For regular drill steel the gage change is $\frac{1}{8}$ in. The finishers for jackhammer steel have a 1½-in. gage, and those for the mounted drills have a $1\frac{9}{16}$-in. gage. Jackhammers and mounted drills have a drill run of 15 in. Bits have a double taper of 5 and 14 deg. with 90 deg. between cutting faces.

Because of the large number of machine sharpeners in operation, it is possible to designate a separate machine for each bit size. By this means it is not necessary to change dies for different bit gages.

Detachable Bits—These are used only on Leyner steel for wagon drills and tripod drills on deep holes. Two men with a large drill average 57 ft. of hole drilled per shift. From 500 to 700 bits are dulled per month.

Shanks are forged on rods at a temperature of 2,000 deg. F. The hardening heat is 1,500 deg. F. Quenching is done in a standard quenching oil. The Brinell hardness is 340 to 387. After upsetting at a temperature of 2,050 deg. F., threads are cut on a lathe in the adjacent machine shop. For hardening, the thread end is reheated to 1,400 deg. F. and quenched in oil until cold.

The maximum diameter of detachable bits used at this property is 3 in. In drilling soft ground or rock that is not abrasive, there are three regrinds or four uses per bit purchased. The distance drilled per bit purchased is 8.56 ft. Before badly worn bits are reground, they are annealed, and after regrinding they are rehardened. The life a sharpening wheel with 12-in. diameter and 2¼-in. thickness averages 320 bits; that of a gaging wheel with 12-in. diameter and 1½-in. thickness is 900 bits. Bits are carried by the miners on a wire loop. A single jack, which has been partially annealed, and a Stillson wrench are used for loosening bits that are difficult to remove from the rod.

For use in hard, abrasive ground, where the first regrind would penetrate the hardened shell, the process of reforging detachable bits instead of regrinding them has been found preferable. By means of special dies for the machine sharpener, one bit per minute can be reforged. Three sets of dies are required for forging a complete set of bits with gage limits of 3 in. to $1\frac{7}{8}$ in. For forging, the entire bit is heated evenly at 1,800 deg. F. in an electric furnace with pyrometer attachment. A short piece of threaded steel rod is used to hold the heated bits in the machine sharpener. It has been found that for best results the rod should be cold when it is screwed into the heated bit. The bits are hardened in an automatic heat-treating machine with pyrometer attachment. They are heated to 1,430 or 1,500 deg. F. and plunged into cold water to a depth of ½ in. for 10 sec. The depth is then gradually increased until they are completely submerged.

Costs—For conventional bits, the direct shop costs over a five-month period for a total of 58,368 bits averaged 8.93c. per bit sharpened. This was exclusive of the steel loss, which was estimated at 3c. for Leyner steel. The cost for each class of regular steel is listed in Table VI.

The cost of transporting and nipping steel used in the open pit amounted to 6.61c. per piece handled. The average shop cost is segregated in Table VII.

The relative cost of sharpening the several classes of regular steel is shown by the ratios or sharpening cost factors given in Table VIII.

Statistics in Table IX compare the life of bit, rate of penetration, loss in bit gage, breakage of steel, and feet drilled per machine shift. They show that the detachable bit with 1¼-in. steel rod drills 12.1 per cent farther and 17.5 per cent faster, with smaller gage loss, than the conventional bit on regular steel.

At this property much of the advantage of the higher drilling speed of the detachable bit and its greater penetration per bit dulled have been counteracted by the increase in the number of broken bits and threads and by the additional difficulties in removing stuck bits. Of the total number of bits used, 4.8 per cent required the use of a Stillson wrench to remove them from the rods. Under these circumstances, detachable bits are economical only in long-hole drilling in the open pit, where transportation and nipping costs for conventional bits are at the maximum rate for the mine—namely, 6.61c. per piece of drill steel handled.

Because of the low cost of trans-

Table VI—Cost of Sharpening Conventional Steel, Western Mine No. 3

Class of steel	Cost per Bit Sharpened, in Cents
Underground steel, average	10.0
Open-pit steel, average	8.93
Plugger	6.6
Jackhammer	12.3
Leyner	15.7

Table VII—Shop Cost of Sharpening Conventional Steel, Western Mine No. 3

	Per Cent of Total Cost
Operating labor	69.02
Operating supplies	3.75
Fuel (diesel oil)	7.28
Electric power	3.01
Compressed air	13.32
Repair labor	1.76
Repair supplies	1.86
Total	100.00

Table VIII—Relative Cost Ratios For Conventional Steel, Western Mine No. 3

Class of steel	Bit Gage, In.	Sharpening Cost Factor
Open pit:		
Plugger		1.00
Short jackhammer		1.64
Long jackhammer		2.25
Long Leyner	1⅛ to 2¾	2.36
Underground:		
Leyner	1⅞ to 1⅛	1.35
	1¾ to 1⅞	1.35
Stoper	1½ to 1⅞	1.50

Table IX—Comparative Data for Conventional Steel and Detachable Bits, Western Mine No. 3

Item	Regular Steel, Conventional Bits	Detachable Bits
Inches drilled per bit	21.99	25.66
Inches drilled per minute	9.49	11.15
Gage of bits used	2¾ to 1⅝	2¾ to $1\frac{9}{16}$
Feet drilled for $\frac{1}{32}$-in. reduction in gage:		
Quartz porphyry	4.84	5.10
Massive sulphides	1.28	1.69
Schist	1.19	1.72
Steel breakage (in percent of times used):		
⅞-in. plugger	0.25	.....
⅞-in. jackhammer	2.9	.....
1-in. stoper	1.0	.....
1¼-in. Leyner	2.0	.....
Bit breakage, percent	1.4	2.1
Feet drilled per machine shift	50	57

porting and nipping regular steel, the use of detachable bits has not been considered for underground work.

Big Canon Mine, Mountain Copper Company, Placerville, Calif.

Summary—At this mine detachable bits are economical only for special work, such as drilling in certain stopes where the transportation and nipping expense for regular steel is excessive. In comparing them with the regular steel, the factor most favorable to them is the outstanding saving in transportation and nipping. The factors unfavorable to them are the reduction in drilling speed with the detachable bits, the excellent bit life for regular bits, and the small steel loss for regular bits.

Rocks Drilled—The prevailing formation is silicified schist in which the ore occurs as a replacement deposit accompanied by pyrite, quartz, ankerite, and calcite. Although the schist is universally dense, its hardness is variable.

Operating Practice—Drifters having a diameter of 3½ in. are used for all drilling except in raising. The common section of drill steel is 1¼-in. hollow-round lugged for lengths under 10 ft. In soft ground, for lengths above 10 ft., 1-in. quarter-octagon is used. One man usually operates a machine, but where several machines are drilling in one face one helper may assist the entire group. Air pressure is 100 lb. at the compressor and about 90 lb. at the drill. The effective actual drilling time per 8-hour machine shift is 2¾ hours.

The drill-sharpening shop is near the collar of the main hoisting shaft. Equipment consists of 2 machine sharpeners, 2 punching machines, 1 pedestal shank-grinder, 1 bit-grinding machine, 1 double-opening oil-burning furnace using a 2-lb air pressure, 1 water quenching tank, 1 oil quenching tank, 1 forge and anvil, 1 air hammer, and various small tools.

Regular Steel—The miner or nipper selects his own drills at the underground steel racks. For hard rock the drill run is 14 in. and for soft rock it is 18 to 24 in. Conventional bits are the four-point end-hole type with 90-deg. angle between cutting faces and with 5-deg. and 14-deg. clearance tapers. All drilling is wet. The 1¼-in. round steel carries a ⅝-in. hole. The gage change, starting with a 2¼-in. bit, is ⅛ in. per 12-in. run. For bits of less than 1⅛-in. gage the change is reduced to 1/16 in. per 12-in. run. The distance drilled per bit dulled is 1.17 ft.

Four men in the shop sharpen and harden an average of 700 pieces of regular steel per day.

Detachable Bits—These were adopted in February, 1936, for use in certain stopes where the cost of transportation and nipping was very high for the regular steel.

With detachable bits, there is one operator for each machine and sometimes one helper for each three machines. Holes in stopes are drilled to a depth of 8 ft. Drifters average 41 ft. per machineshift. A 3-lb. annealed hammer is provided to facilitate the removal of bits that are not readily unscrewed. About 225 detachable bits are dulled per day. The distance drilled per bit dulled is 1.26 ft. Bits are the four-point, end-hole type. The average number of bits broken is 0.28 per cent of the total number used. Average feet drilled per rod broken is 76. Approximately one-eighth of total rod breakage is at the thread. Rods are 1¼ in. in diameter.

The drill run is 15 in. with ⅛-in. gage change. Bits are rehardened after the second regrind or third use, and thereafter on each regrind to a minimum size of 1⅛ in. Since the last three sizes are rehardened, the bits are annealed before regrinding. Since the rehardening practice was adopted there has been an increase in the number of regrinds to 4.8, which is equivalent to 5.8 uses per bit purchased. Life of a bit is 7.3 ft. The grinding wheels are 12 in. in diameter. A forming wheel sharpens 500 bits and a gaging wheel gages an average of 300 bits. Approximately 180 bits are sharpened and gaged per man per shift on grinding.

Shanks on rods are forged at an estimated temperature of 1,800 deg. to 1,900 deg. F. They are quenched in a standard brand of quenching oil after having been heated to approximately 1,450 deg. F. The thread end of the rod is turned on a lathe at the mine machine shop. It is then heated to an estimated 1,450 deg. deg. F. and sprinkled with a hardening powder. After a few seconds of this treatment it is quenched in oil until cold.

The bit carrier is a loop of wire. The miner picks up sharp bits at the shop on the surface and delivers them at the close of the shift to the shaft station. A nipper returns them to the shop.

The comparative costs in Table X show the results of a three-weeks' test made previous to the adoption of the detachable bits for special work. It does not include the loss of miners' time in handling steel nor the cost of operating machine drills.

The operating data in Table XI show drilling speed, penetration per bit dulled, and loss of steel when drilling with conventional and with detachable bits.

Table X—Comparative Costs: Regular Steel vs. Detachable Bits. Western Mine No. 3

	Regular Steel			Detachable Bits	
	Cost per Bit Dulled	Cost per Foot Drilled	Unit Cost	Cost per Bit Dulled[a]	Cost per Foot Drilled
New bits	.....	.....	$0.27	$0.0530	$0.0420
Regrinding bits, total	.....	.....	0.0611	0.0491	0.0390
Labor	.....	.....	0.0346	.....	.....
Wheels	.....	.....	0.0265	.....	.....
Reconditioning rods, total	.....	.....	.....	0.0048	0.0038
Shanks	.....	.....	.....	0.0040	.....
Threads	.....	.....	.....	0.0008	.....
Steel loss	$0.0200	$0.0171	.....	0.0205	0.0162
Sharpening	0.0563	0.0481	.....	.....	.....
Fuel oil and miscellaneous shop supplies (estimated)	0.0075	0.0056	.....	0.0035	0.0028
Nipping (estimated)	0.0350	0.0300	0.035	0.0100	0.0080
Totals	.....	0.1008	.....	.....	0.1118

[a] Based on 5.1 uses per bit purchased.

Table XI—Operating Data. Western Mine No. 3

Item	Conventional Bits	Detachable Bits
Drilling speed, inches per minute actual cutting time	4.4	4.0
Inches drilled per bit dulled	14.0	15.1
Breakage of rods, percent of times used	1.07	1.65
Loss of steel from all causes, pounds per bit dulled	0.167	[a] 0.171

[a] Exclusive of steel in detachable bits.

Western Mine No. 4

Summary—By adopting detachable bits a saving of 45.7 per cent is shown for bit-sharpening cost per foot drilled. Comparative drilling data indicate a considerable saving in complete costs. No small factor in the success of detachable bits at this property is the carefully controlled operations in the company's shops for reconditioning drill rods and bits.

Rocks Drilled—The prevailing formation is monzonite porphyry with some diorite and rhyolite. The rock varies from soft to very hard and from sticky through ravelly to dense and uniform. The average drilling is quite abrasive.

Operating Practice—Since Oct. 1, 1934, all drilling has been done with detachable bits. Vertical holes are drilled dry in an open pit to an average depth of 28 ft. with 3¼-in. drills mounted on tripods and with 4-in. wagon drills. For plugging, a 2⅝-in. machine is employed. Air pressure is 100 lb. at the compressor and 90 lb. at the drill. Over a recent six-month period an average of 6.9 ft. was drilled per bit dulled. The life of a bit is 48.3 ft.

(To be continued)

—Excerpted from United States Bureau of Mines Information Circular No. 6951, written by McHenry Mosier. Previous published circulars on the same subject by the same author are I.C. 6877, 6911, and 6936.